ENSR

Northern Area Drift Aquifer Gradient Control Work Plan

W 439

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NORTHERN AREA DRIFT AQUIFER GRADIENT CONTROL WORK PLAN

Submitted to the
United States Environmental Protection Agency, Region V
and
Minnesota Pollution Control Agency

Submitted by
City of St. Louis Park
St. Louis Park, Minnesota

Pursuant to
Remedial Action Plan Section No. 9.5.1
Exhibit A to the Consent Decree in
United States of America, et al. v. Reilly Tar & Chemical Corp. et al.
U.S. District Court, District of Minnesota, Civil No. 4-80-469

February 22, 1994

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SITE MANAGEMENT PLAN
FOR THE DRIFT AQUIFER GRADIENT CONTROL WELL
AT THE REILLY TAR & CHEMICAL CORPORATION - ST. LOUIS PARK SITE

February 22, 1994

SITE MANAGEMENT PLAN

The purpose of this report is to outline the work required to install one gradient control well for the Northern Area of the Drift Aquifer. This report includes the following sections:

- Site Management Plan
- Quality Assurance Project Plan
- Health and Safety Plan
- Community Relations Plan

Based on the water quality data presented in the Drift-Platteville Aquifer Northern Area Remedial Investigation Report (City of St. Louis Park (City), 1989) and the Drift-Platteville Aquifer Northern Area Supplemental Remedial Investigation Report (SRI, City of St. Louis Park, 1992), the Drift Aquifer Northern Area Feasibility Study, October 21, 1992, recommended the installation of a supplemental gradient control well to limit the spread of polynuclear aromatic hydrocarbons (PAHs) and phenolics in the Northern Area of the Drift Aquifer.

The Drift Aquifer Feasibility Study noted that:

> "Section 9 of the CD-RAP specifies the installation and operation of one or more gradient control wells to prevent the further spread of ground water in the Northern Area of the Drift-Platteville Aquifer exceeding any of the drinking water criteria defined in CD-RAP Section 2.2. Thus, operation of a gradient control well placed downgradient of a contaminant source can act to capture the flow from the source and limit the spread of contamination. As such, the CD-RAP provides the objective of the remedial action, as well as a mandate to the Potentially Responsible Parties (PRPs) to control the gradient in the Northern Area of the Drift Aquifer. Therefore, the individual analysis of this alternative builds on previous evaluations to develop and screen alternatives that were conducted during various studies referenced in the CD-RAP.
>
> In accordance with the remedial action objective stated in the CD-RAP, this alternative is specific to ground water in the Northern Area of the Drift Aquifer and is not a site-wide remedy. The Northern Area of the Drift Aquifer gradient control well will operate independently of other remedial actions required by the CD-RAP for the purpose of preventing the further spread of contamination."

The following Site Management Plan (Plan) discusses the installation of the Northern Area Drift Aquifer gradient control well.

The proposed Drift Aquifer gradient control well location is indicated in Figure 1. The proposed location is on property owned by the City. The new well will be designated well W439.

WELL W439 DESIGN, DRILLING PLANS AND PROCEDURES

The design, drilling plans and procedures are for construction of a 6-inch diameter well that will accommodate a 4-inch submersible pump. Figure 2 is a schematic drawing showing the proposed well construction.

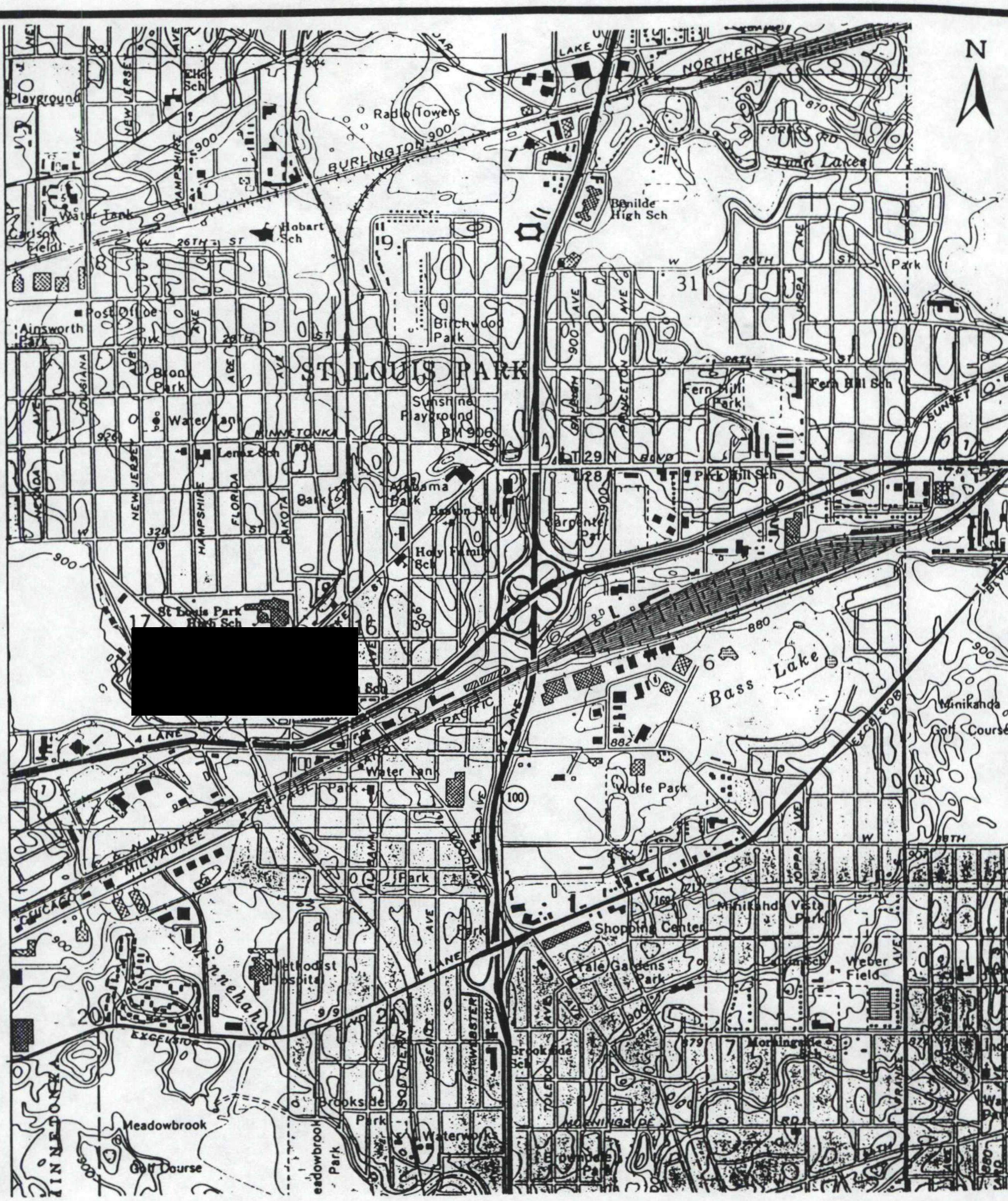
Design considerations for well W439 are as follows:

- A preliminary boring will be constructed prior to well installation. The purpose of this boring will be two-fold. The first objective of the boring will be to obtain geotechnical information on the subsurface to aid in the design of the pumphouse. The second objective of the boring will be to define the stratigraphy at this location to aid in the design of the well screen. The length and slot size of the screen will be structured accordingly following review of the sieve analysis.

- Following selection of screen slot size, a sand pack will be designated based upon the sieve analyses of the layer revealing the finest material. In turn, the screen selected will retain 90 percent or more of the filter pack material.

- The well will be drilled using direct rotary drilling techniques to the depth of the top of bedrock (approximately 90 feet). A nominal 10-inch hole will be drilled to allow for proper grout seal of the 6-inch well casing. A minimum bit size of 10 inches will be used to comply with Minnesota Department of Health (MDH) well code requirement of 4 inches between casing and borehole diameters.

- The well will be screened in the lower one-third of the Drift Aquifer, to maximize available drawdown. The well will have approximately 30 feet of screen in a 90-foot well. The well screen will be constructed of stainless steel.



• Sanitary Sewer Manhole Location

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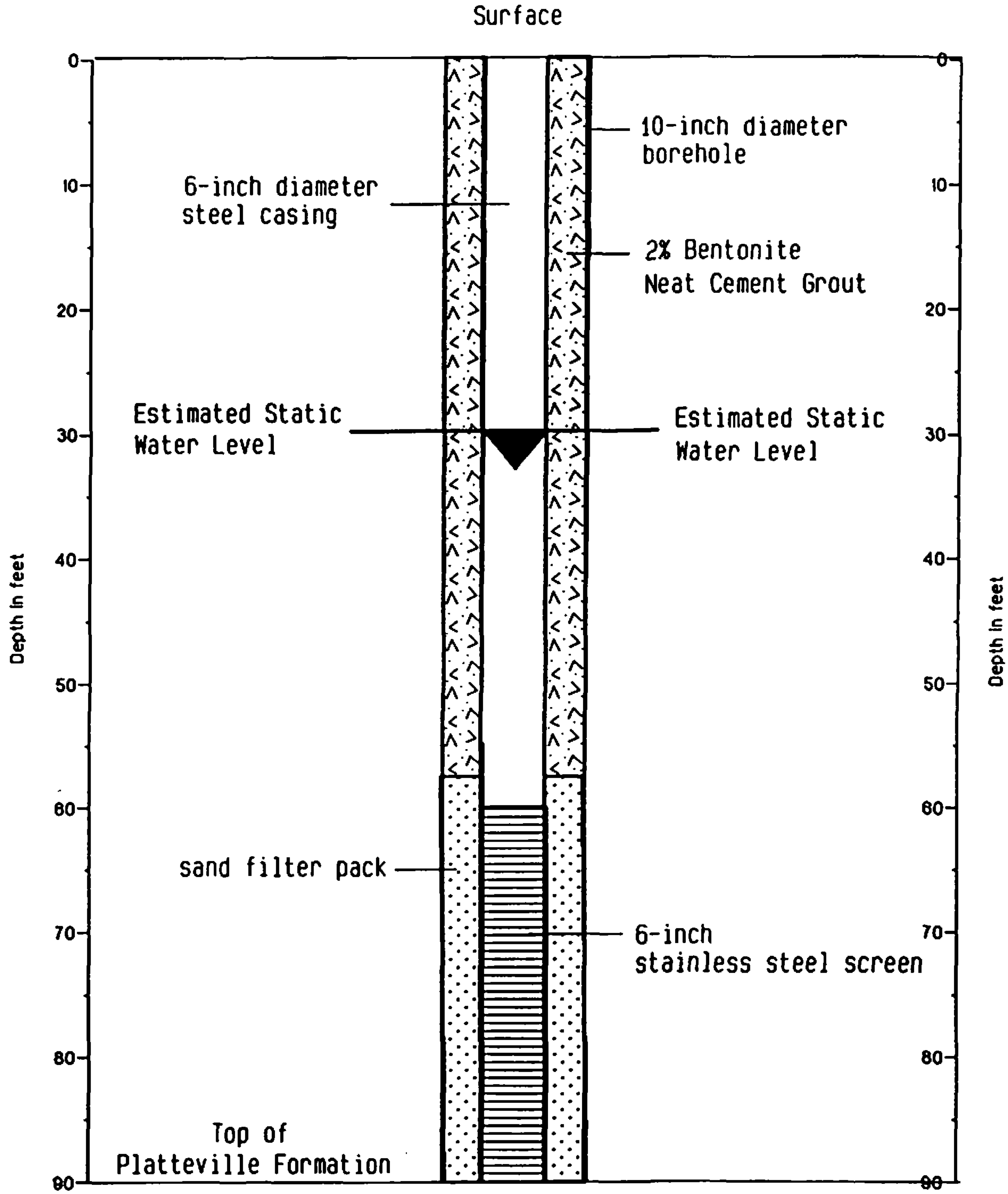
Figure 1
Proposed Location of Drift Aquifer Gradient Control Well (W439)
St. Louis Park, Minnesota

FILE: 1620013	DATE: 1/29/93	PRJ. NO. 1620-013-200

DRIFT MONITORING WELL



NOTE: Exact Structure of Well will be determined following the proposed preliminary boring

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Figure 2

Drift Monitoring Well Diagram

St. Louis Park, Minnesota

1620-013-200

- The well screen slot size will be based on mechanical sieve analyses of soil samples retrieved from the elevation at which the screen will be placed. A slot size that will hold out 40 to 60 percent of the material will be used. Additionally, the screen intake velocity will be less than 0.1 foot per second. Blank screen sections (zero slot) or casing will be used adjacent to any fine-grain layers that may be present.

- The steel well casing will extend from the top of the well screen to the ground surface (leaving an appropriate stickup for a well head). The well casing will be pressure-grouted using a 2 percent bentonite neat cement grout mix.

- Upon completion of the well, a sand pack will be developed around the well screen by a high velocity jetting and pumping technique.

- Upon completion of the well, a reference point for measuring water levels will be established at the well head. The horizontal location and vertical elevation of this reference point will be surveyed.

A licensed well driller will be contracted to install well W439. The licensed well contractor will use direct rotary techniques to advance the boreholes. The casing will be grouted into place with a tremie pipe. All grout and other material specifications will conform with the requirements of the Minnesota Well Water Construction Code. The drilling site will be kept neat and clean at all times. Drilling fluids, cuttings, and other debris will be handled in accordance with the Contingency Plan (Appendix A). Drilling tools and equipment will be steam cleaned before and after drilling. A record containing documentation of these procedures, field notes, well logs, measurements, etc., will be maintained.

PUMP SPECIFICATIONS AND INSTALLATION

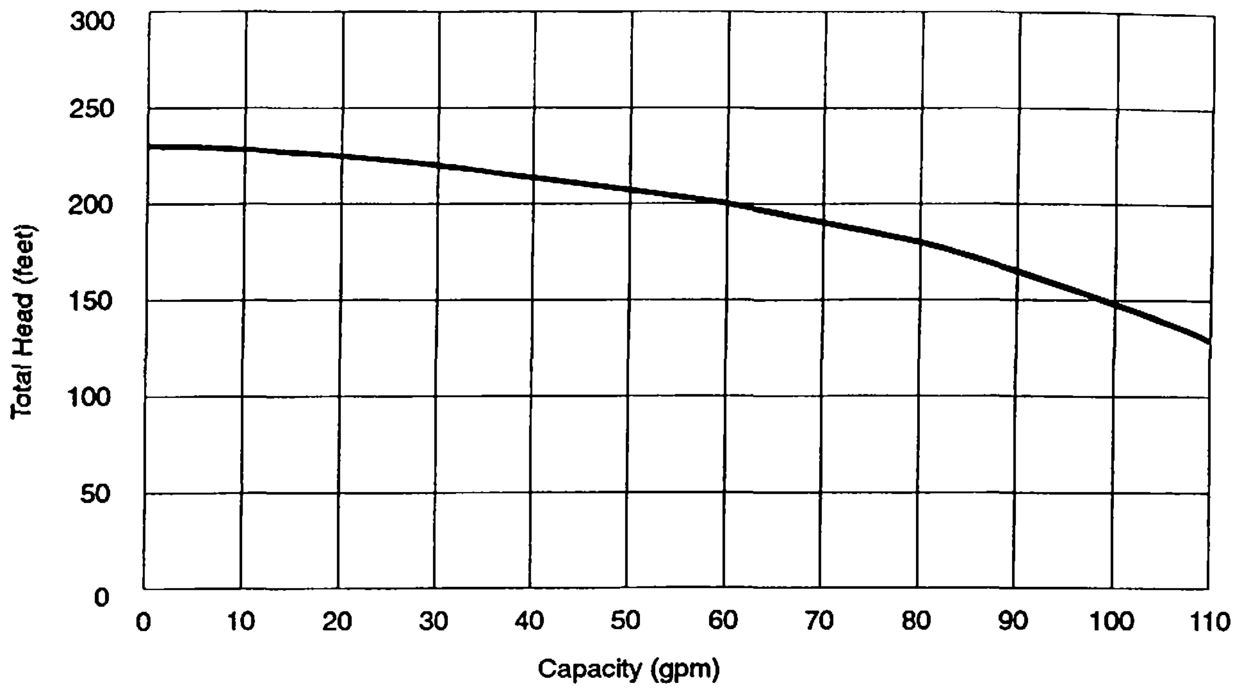
The monthly average pumping rate for well W439 is estimated to be 50 gallons per minute (gpm). The total head lift that the submersible pump will be required to overcome is currently estimated to be no more than 135 feet. A 4-inch diameter, 3-phase, 5-horsepower submersible pump will be required to achieve the 50 gpm pumping rate and total head lift (Figure 3). This pump specification will be re-evaluated following the aquifer test to ensure the proper head calculations are considered.

The construction materials for the submersible pump and discharge pipe are as follows:

- The submersible pump will be constructed of stainless steel.

Grundfos Pump Model SP16-5

Performance Curve



Dimensions and Weights

Model No.	HP	Length	Approx. Unit Shipping Weight
SP16-5	5	44⅜ inches	87 lbs

Nominal Flow Rate: 80 gpm
Flow Range: 48 to 110 gpm
Pump Outlet: 3 inches npt

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Figure 3
Pump Specification for W439
St. Louis Park, Minnesota

FILE: 1620013c	DATE: 2/14/94	PRJ. NO.: 1620-013-200

- The submersible pump's natural butanol rubber (NBR) impeller seal ring will be retrofitted with teflon.

- A 3-inch national pipe thread (NPT) discharge pipe will extend from the pump outlet to the point of discharge. The discharge pipe will be constructed of galvanized steel or ductile iron.

The submersible pump will be installed within well W439 safely below the pumping water level, as determined through the aquifer tests. The pump will be installed within the casing or a blank screen section to prevent cavitation or corrosion of the well screen adjacent to the pump intake. The use of low carbon galvanized steel, ductile iron and stainless steel components as well as retrofitting the NBR components with teflon components will increase the operational life expectancy of the system. The final placement of the pump will be determined following the review of the aquifer test data.

AQUIFER TEST PLAN

An aquifer test will be conducted using well W439 as the pumping well and other Drift Aquifer monitoring wells to observe drawdown. The aquifer test will determine the hydrologic properties of the Drift Aquifer at this location, and this information will be used as the basis for the final design details of the well (pumping rate and pump size). The gradient control well pump tests will be performed in accordance with ENSR Standard Operating Procedure Number 7730, Aquifer Test and Data Evaluation (Appendix B) as modified in this Plan. Where there are differences between procedures described in Appendix B and this Plan, this Plan will have priority. Parameters to be ascertained during the aquifer tests include local hydraulic conductivity and storativity of the Drift Aquifer.

Estimated drawdowns during the Drift Aquifer test will be calculated using the analysis by Neuman (1975). The analysis incorporates the following assumptions:

- Fully penetrating wells with no storage capacity
- Uniformly porous unconfined aquifer underlain by an aquiclude
- Homogeneous, anisotropic aquifer of infinite extent and constant thickness
- Drawdown negligible with respect to saturated thickness

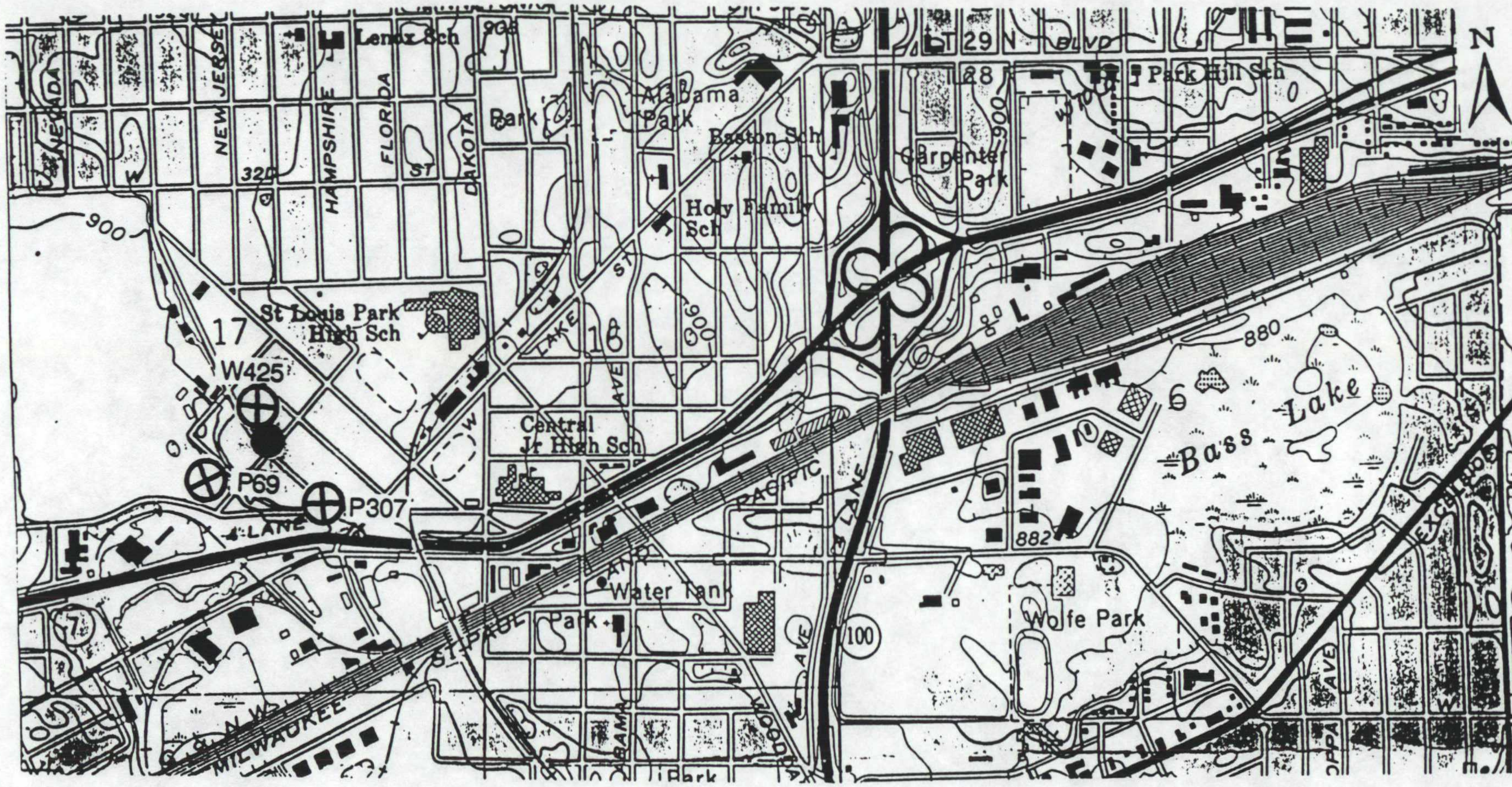
Based on a horizontal hydraulic conductivity of 1030 gpd/ft^2, aquifer thickness of 65 feet, storage coefficient of 0.0001, specific yield of 0.1, ratio of vertical to horizontal conductivity of 1:10, and discharge rate of 200 gpm, 1 foot of drawdown is expected at Drift Aquifer wells 300 feet from the pumping Drift Aquifer gradient source control well. (Hydraulic conductivity is estimated based on previous aquifer tests in the area while other parameters are based on typical literature values for glacial drift.) Measurable drawdowns are expected at Drift Aquifer monitoring wells within 1000 feet of the proposed Drift Aquifer gradient control well. Three potential monitoring wells currently exist within 1000 feet of the proposed well location. These wells are W425, P69 and P307, located 50 feet north, 500 feet southwest, and 650 feet southeast, respectively, of the proposed well location (Figure 4).

In addition, hourly water level measurements will be collected at a distant well upgradient (beyond the pumping well cone of influence) in order to identify extraneous influences. The use of a distant well (well W2) will allow correction of observed drawdowns in the event of precipitation or some other extraneous factor during the aquifer tests. If possible, the aquifer tests will be conducted during non-rain events.

An In-Situ Hermit Model SE-2000 Hydrologic Analysis System or equivalent will be used in conjunction with pressure transducers to log water level data at the pumping well and at the observation wells. Use of a computerized data logging system will allow accurate collection of early-time measurements during both the pumping and the recovery phases of the aquifer tests.

During the Drift Aquifer test, the Drift Aquifer gradient control well will be pumped at the rate of approximately 200 gpm, if possible. Discharge will be conveyed to the sanitary sewer located 50 feet south of the proposed well location on Gorham Avenue (Figure 1). The well head and the discharge line will be equipped with a flowmeter and flow control valve to measure and control the discharge rate.

The aquifer test at well W439 will consist of three phases: an initial phase to determine antecedent trends, a pumping phase, and a recovery phase. During the initial phase water levels will be recorded each hour for 48 hours prior to pumping. The pumping phase will last approximately 72 hours. The exact duration of the pumping phase will be determined based on data collected during the test. When drawdown in W439 has stabilized to within 0.10 feet in 12 hours, the pumping phase will be terminated. Water levels will be recorded every 10 seconds through the first 2 minutes, every 30 seconds through the first 5 minutes, every minute through the first 10 minutes, every 5 minutes through the first hour, every 15 minutes through the third hour, every 30 minutes through the fifth hour, every hour through the first day, and every four hours until the end of the pumping phase. Water levels will then be recorded during the recovery phase which will continue until water levels have stabilized near pre-test conditions. The monitoring frequency schedule during recovery will be the same as that followed during the pumping phase (every 10 seconds through the first 2 minutes, every 30 seconds the first 5



⊗ Monitoring Well Location

Proposed Drift Aquifer Gradient Control Well

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Figure 4
Monitoring Well Locations
St. Louis Park, Minnesota

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minutes, every minute the first 10 minutes, every 5 minutes the first hour, every 15 minutes through the third hour, every 30 minutes through the fifth hour, every hour through the first day, and every 4 hours until the end of the test.)

PUMPHOUSE DESIGN AND CONSTRUCTION

The design of the pumphouse for well W439 will be similar to other Reilly Industries, Inc. (Reilly), site pumphouse construction specifications (i.e., the single-well pumphouses at wells W23 and W105). The intent is to provide a structure and equipment suitable for a long-term operation (possibly decades) with minimal maintenance and operating requirements. The pumphouse is designed as a 7-foot, 4-inch by 7-foot, 4-inch walk-in building with room for maintenance work. The roof is equipped with a removable panel to allow for access to the well by a drill rig.

The pumphouse will be a solidly-built masonry structure with a concrete floor. The wall structure will be masonry block with a brick veneer to make a more attractive building. Insulation will be provided in the roof and walls and under the floor for energy efficiency. A City parking lot is located at the proposed well location and will provided access and off-street parking for inspection and maintenance personnel. Electric heating and lighting and a floor drain will be provided inside the pumphouse. The floor drain will discharge via a gravity line to an existing sanitary sewer manhole on Gorham Avenue South, approximately 50 feet south of the proposed well location.

The drilling method prescribed for well W439 will allow for the collection of geotechnical information to aid in the design of the pumphouse foundation support. The drilling method includes soil sampling that will be done in accordance with ASTM specifications D-1586 (Penetration Test and Split-Barrel Sampling of Soils).

Blueprints for the well W439 pumphouse are presented in Appendix C. Bid documents to be used in obtaining bids and contracting for the construction work will be submitted to the Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) upon receipt of notice of acceptance of this Plan and authorization to proceed. As-builts may vary slightly, based on the geotechnical information obtained during construction of the well.

The pumphouse floor grade will be slightly above the existing grade so as to provide drainage away from the building. The proposed well location is not within a 100-year floodplain.

PIPING DESIGN AND CONSTRUCTION

The piping design for the Drift Aquifer gradient control well is based on providing long-term, low-maintenance operation and will be similar in construction to the other piping construction specifications in other Reilly pumping wells. Galvanized pipe or ductile iron pipe will be used from the wellhead to the sanitary sewer. The discharge line inside the pumphouse will be provided with various control equipment, including a wellhead pressure gauge, a shut-off valve, a flow controller, a flow meter, and a sample tap. The flow meter will signal a combined circular chart recorder/totalizer. The discharge from well W439 will be under pressure to an existing sanitary sewer manhole on Gorham Avenue.

Blueprints for the well W439 piping and sanitary sewer connection are presented in Appendix C. The City shall submit complete bid documents to the EPA and MPCA upon receipt of notice of acceptance of this Plan and authorization to proceed.

OPERATION AND MONITORING

The City will notify the EPA and MPCA when W439 construction is completed and ready for inspection and approval. Pumping of well W439 will begin within ten days of receiving approval of its construction from the EPA and MPCA Project Leaders. Well W439 will be pumped at a monthly average rate of 50 gpm (subject to aquifer test results), until a request to cease pumping is approved pursuant to RAP Section 9.1.4. Further details on the inspection, approval and start-up process are provided in Section 6.0 of the Quality Assurance Project Plan.

Well W439 will be operated and maintained by the City. The City will inspect the pump operation at least twice per week. All inspections will be noted in a log book using a form like the one shown in Figure 5. The flow meter totalizer readings, date, time, inspector's name, and any relevant comments will be recorded in the log during each inspection. The log book will be kept at the pumphouse, with a backup copy kept at City Hall. The log book and circular recorder charts will be maintained as permanent records by the City in accordance with applicable state and local statutes. The EPA and MPCA will be notified by the City before any of these records are destroyed.

Well W439 will be pumped continuously, except for brief shutdown episodes required for maintenance and/or repair. The City will notify the EPA and MPCA Project Leaders of any shutdown lasting more than three working days, with an explanation of the cause and an estimated date when pumping will be restarted. Shutdown periods for maintenance or repair are expected to be brief and infrequent because of the simple equipment involved.

FIGURE 5

Inspection Log for the Drift Control Well

		Drift Gradient Control Well		
Date	Time	Flow Totalizer Reading (gal)	Calculated Average Flow Rate (gpm) for Month-to-Date	Comments

Well W439 will normally be pumped at a rate of 50 gpm (subject to aquifer test results), but this rate will be increased as required after shutdown periods in order to maintain a monthly average rate of 50 gpm. The monthly average rate will be calculated on a calendar month basis using the flow totalizer readings in the inspection log. Average flow rates for the month-to-date will be calculated and noted in the log book at least once a week to help ensure that the correct monthly average rate will be met each month. The circular charts from the flow recorder will not be used to determine compliance with the monthly average rate requirement because the totalizer gives more accurate readings. The circular charts are intended to document any variations in flow rate and any shutdown periods.

Monthly average pumping rates for W439 will be reported for the applicable calendar months in the progress reports required by Park K of the CD. In addition, the City will provide copies of the log book and circular charts to the EPA and MPCA Project Leaders upon request.

Control of the well discharge rate will be accomplished using both the flow controller and the recorder/totalizer. The desired flow rate can be set initially by the scale on the flow controller. Over a period of hours or days, the totalizer readings can be used to check the flow rate and the initial controller setting adjusted accordingly. Once routine operation is established, the totalizer readings and times noted in the log book - or the circular chart recorder reading - can be used to check the flow rate and the flow controller setting adjusted as necessary.

The discharge from W439 will be monitored quarterly in 1994 for carcinogenic PAH, other PAH, and phenolics pursuant to the methods described in the 1994 Sampling Plan.

GROUND WATER MONITORING

In accordance with the CD-RAP and the Sampling Plan for 1994, the Drift Aquifer wells scheduled to be sampled in 1994 are:

- W2
- W10
- W15
- W116
- W117
- W128
- W135
- W136
- W420
- W422
- W423
- W425

The above wells will be sampled during the first half of 1994 and will serve as baseline water quality prior to star up of W439.

This Work Plan includes sampling nine Drift Aquifer monitoring wells to obtain water level and water quality data for evaluating the performance of well W439. These nine wells are:

- W2
- W423
- W425
- W136
- W427
- P307
- P308
- W117
- W5

The locations of these wells are shown on Figure 6. W439 and the other nine wells will be sampled following well house construction and sewer connection within one week after start up of W439.

All sampling and analysis for PAH and phenolics will be done in accordance with the 1994 Sampling Plan.

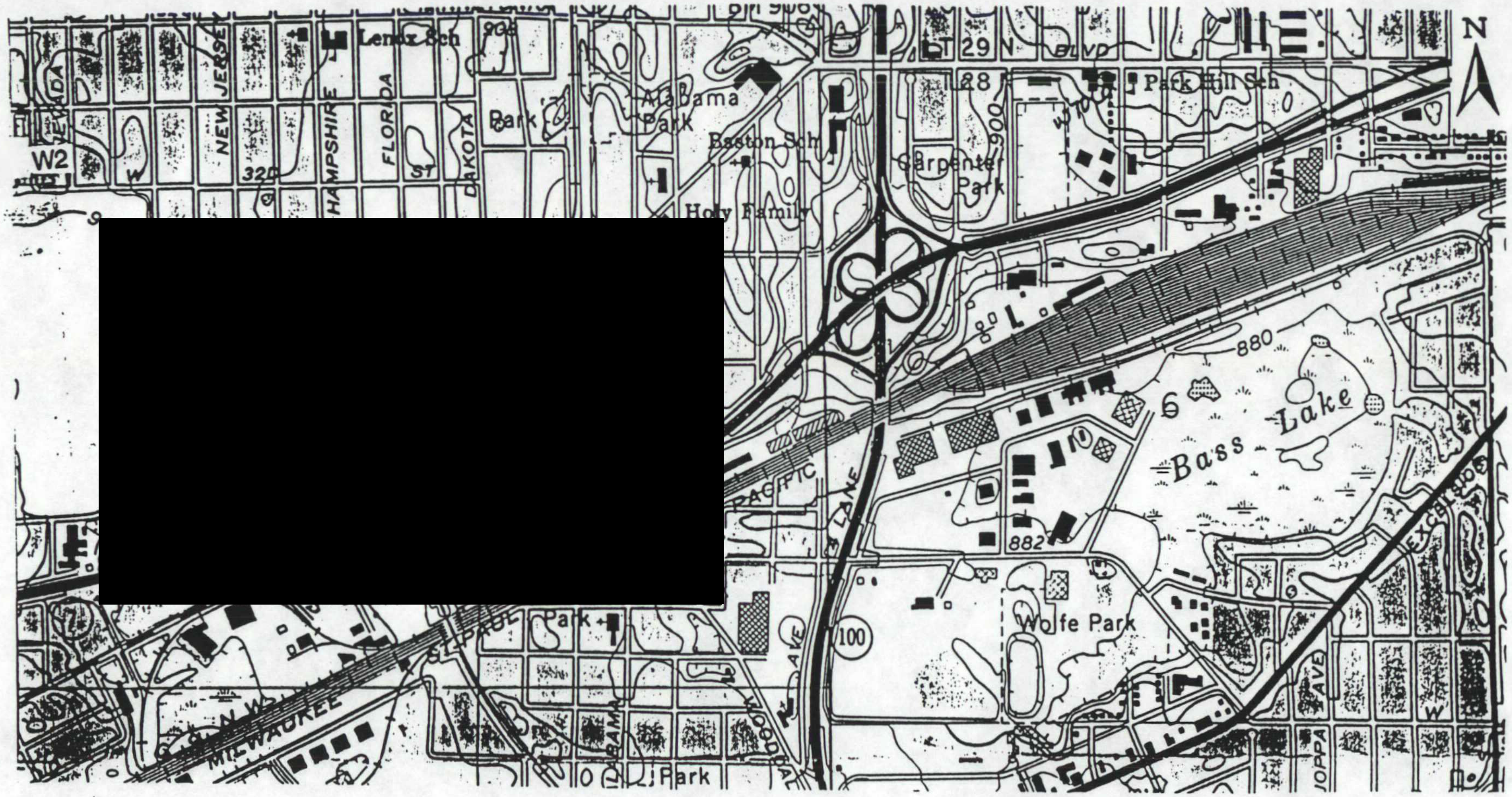
CONSTRUCTION REPORT AND SCHEDULE

The City will prepare a report which presents the installation logs for W439, the results of the aquifer tests, results of the ground water sampling event, and descriptions of any field adjustments to the approved design. The report will be submitted to the EPA and MPCA approximately 30 days following the Agencies' notification of approval of construction.

Figure 7 presents the construction schedule currently planned for well W439. This schedule is subject to modification as the work progresses. Figure 7 indicates a total schedule of 180 days for completing the well W439 construction project.

ANNUAL MONITORING REPORT

By March 15 of each year, beginning in 1995, a report of the results of all monitoring during the previous year will be submitted which includes information obtained from this Plan. This report will contain information as specified in the CD-RAP as well as the following:



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● Proposed Sampling Well Locations

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Figure 6
Proposed Sampling Well Locations
St. Louis Park, Minnesota

FILE: 1620013	DATE: 1/29/93	PRJ. NO.: 1620-013-200

FIGURE 7

Project Schedule
City of St. Louis Park

TASK	MONTHS 1	2	3	4	5	6
Approval of Work Plan[1]	◊					
Well Drilling and Installation		□□				
Pump Test		□□				
Well House Construction and Sewer Connection[2]			□□□□	□□□□	□□□□	
Inspection[3]						◊
Sampling						◊
Construction Report					□□□□	□□□□

[1] Contingent upon MPCA approval schedule

[2] Contingent upon contract agreements

[3] Contingent upon EPA and MPCA timing

- Results of all water level measurements and chemical analyses completed as a result of the construction of W439

- A discussion of the monitoring (e.g. water quality trends) and water level measurements with respect to the gradient control system.

CESSATION

Cessation of the Drift Aquifer Gradient Control Well (W439) will occur when operation of the well is no longer required to limit the spread of contamination in the Northern Area.

APPENDIX A

Contingency Plan

CONTINGENCY PLAN

It is unlikely that soils contaminated with coal tar materials will be encountered during the well drilling operations because the drilling site is located away from, and is at a higher elevation than the Reilly site. However, to be consistent with other Reilly site Work Plans, a Contingency Plan for contaminated soils is described below.

If any contaminated soils are encountered during excavation work, the Engineer or his representative will determine if the material is suitable for use as backfill based on the following visual determination:

- Excavated material containing creosote or coal tar constituents may be used as backfill material if the creosote or coal tar constituents have not acquired a cementatious nature so as to artificially bond the excavated soil structure as a concrete unit and if the creosote or coal tar constituents are not encountered in a definable homogeneous mass of excessive concentration or amount sufficient to preclude heterogeneous mixing with uncontaminated soils from the excavation area.

Any contaminated materials suitable for backfill will be covered with at least 12 inches of clean soil before final grading. Any contaminated soils that are not suitable for backfilling will be stockpiled at a temporary storage facility until all of the work required for the well construction has been completed. The stockpiled material will then be disposed of in accordance with all applicable state and federal regulations at a RCRA hazardous waste treatment/storage/disposal (TSD) facility legally permitted to accept the material and approved by the EPA and MPCA. The City will be responsible for said disposal activities.

The City will be responsible for keeping the EPA and MPCA informed of all significant actions involving excavation and disposal of contaminated soils and use of a temporary storage facility. All actions, decisions and communications by the City, EPA and MPCA in dealing with contaminated soils will be in accordance with and subject to the provisions of Parts I, J, and O of the Consent Decree.

CONTINGENT ACTIONS FOR CONTAMINATED WELL CONSTRUCTION MATERIALS

It is possible that solid and/or aqueous materials contaminated with creosote or coal tar constituents will be generated during the well construction work described in the project specifications. Any contaminated solids will be handled as excavated as described above, namely:

- Contaminated solids suitable for use as backfill will be used as such

- Contaminated solids unsuitable for use as backfill will be stockpiled in a temporary storage area for subsequent disposal at a RCRA TSD facility

Ground water and drilling fluids generated during well construction work will be classified as contaminated if the water exhibits a discernible oil sheen or oil phase. Contaminated water will be pumped to the sanitary sewer if it contains less than 10 percent organic material. Estimates of flow rate, disposal volume and water quality will be established and the Metropolitan Waste Control Commission (MWCC) will be informed before the discharge to the sanitary sewer if the estimated flow exceeds 150 gallons per workday. Contaminated liquids containing more than 10 percent organic material or failing to receive MWCC approval for discharge will be disposed of in accordance with all applicable local, state and federal rules and regulations and Part T of the Consent Decree. Uncontaminated water will be disposed of in the storm sewer or by other means acceptable to the City of St. Louis Park.

Any use of a temporary storage facility for contaminated well construction materials will be as described above for contaminated soils.

The City will keep the EPA and MPCA informed of all significant actions involving the generation and disposal of contaminated well construction materials and use of a temporary storage facility. All actions, decisions and communications by the City, EPA and MPCA in leading with contaminated well construction materials will be in accordance with and subject to the provisions of Parts I, J and O of the Consent Decree.

APPENDIX B

ENSR SOP 7730 - Aquifer Test and Data Evaluation

1.0 PURPOSE/APPLICABILITY

This SOP is concerned with the procedures necessary for aquifer-test design, aquifer-test performance and general techniques of data evaluation. The scope of this SOP is limited to general procedures necessary to properly understand and organize an aquifer test. A detailed test plan should be prepared before beginning an aquifer test, following the general guidelines given in this SOP. More detailed studies concerning aquifer tests and analyses can be found in any of the various references listed at the end of this SOP.

Aquifer tests are generally conducted to evaluate the hydraulic properties of an aquifer system as they relate to remedial action design criteria and/or water supply studies.

2.0 RESPONSIBILITIES

The project manager or his delegate (a qualified hydrologist, hydrogeologist, geologist, etc.) will have the responsibility of designing an appropriate aquifer-test program specific to the project needs. Additionally, he or she will be responsible for coordinating any second or third parties and ensuring that all procedures are performed in accordance with SOP and the aquifer-test plan. Any deviation from the SOPs or the aquifer-test plan will be fully documented in a daily log book.

2.1 ERT Personnel

The ERT project manager or his delegate will be responsible for:

- Aquifer-test design - This will include review of pertinent hydrogeologic literature (reports, boring and well logs, etc.) and, based on that information, the preparation of a site-specific aquifer-test plan that specifies: (1) the placement of monitoring and recovery wells; (2) site-specific discharge rates and point of discharge; and (3) time intervals at which water level data will be collected.
- Aquifer-test performance - This includes: (1) implementation of the aquifer test in accordance with job-specific protocols given in the aquifer-test plan; and (2) recording aquifer-test data.
- Reduction and evaluation of aquifer-test data - This will include: (1) evaluation of antecedent water-level trends; (2) evaluation of the pumping phase water-level data; and (3) evaluation of the recovery phase water-level data.

2.2 Drillers

It is the responsibility of the driller to provide the necessary equipment for monitoring and recovery well installation as specified in SOP 7220 and as modified by the project manager or his delegate. If the driller is to supply submersible pumps, generators, flow meters, discharge lines or any other equipment necessary to the job the project manager shall explain in detail to the subcontracted driller the job-specific equipment needs. During setup and/or installation of the equipment the project manager shall oversee the performance and adherence to the test plan. Additionally, during the entire aquifer test, if the driller is involved in activities such as monitoring the performance of the pumps, fuel supplies, etc., the project coordinator shall ensure that the driller adheres to the test plan.

2.3 Second or Third Parties

During the aquifer test other involved parties shall be monitored for performance and adherence to the test plan. Any deviation shall be corrected and fully recorded by the project coordinator in a daily log book.

3.0. SUPPORTING MATERIALS

The following list identifies the types of equipment which may be used during an aquifer-test program. Exact equipment needs will be project-specific and will be detailed in the aquifer-test plan.

3.1 ERT

- Electric water-level indicator
- Steel surveyors tape and plopper
- Pressure transducer and data logging system
- 100-foot surveyors tape
- Field portable printer or computer (compatible with data logging system)
- Aquifer-test record sheets/clip board
- Daily log book

- Log-log and semi-log graph paper
- Watch
- Calculator
- Decontamination equipment (required for personal protection during aquifer tests in potentially contaminated environments or if sampling for chemical analysis will be included):

  Alconox detergent
  Chemical-free paper towels
  Deionized water w/squeeze bottle
  Methanol w/squeeze bottle
  Trash bags
  Tap water (5 gallons)
  Buckets

- Ground-water sampling kit from lab (if applicable)
- Personnel health and safety equipment (as specified by the HSO)
- Submersible pump
- Aeration column (for stripping volatiles out of discharged ground water)

3.2 Driller

- Tankers for collecting discharged ground water
- Submersible pump
- Generator and fuel
- Flow meters and control valves
- Discharge line

3.3 Supporting SOPs

- 2005 - Numerical Analysis and Peer Review
- 7220 - Monitoring Well Construction and Installation

4.0 GENERAL AQUIFER TEST DESIGN AND OPERATIONAL PROTOCOLS

Aquifer tests are broken down into four separate phases, all of which must be performed for proper evaluation of the hydraulic properties of the aquifer. Any deviation from these four phases must be fully documented and justified. These four phases are:

- Aquifer-test design
- Antecedent water-level monitoring
- Pumping
- Recovery
- Aquifer-Test Design

Prior to an aquifer test an initial review of site hydrological and geological conditions must be performed and a detailed aquifer-test plan must be prepared. Information concerning aquifer thickness, aquifer type, transmissivity, hydraulic conductivity, storativity, etc., can be obtained or estimated from the following types of sources:

- Boring logs
- Well records
- USGS water resource reports
- State water resource reports
- Textbook tables and charts

The hydrogeologic information gathered from these sources is necessary to:

- estimate the cone of influence at a specific discharge rate;
- properly and strategically locate monitoring wells and the recovery well; and
- determine the proper time intervals at which time-drawdown data should be collected.

The following subsections provide guidelines for preparation of aquifer-test plans.

4.1.1 Cone of Influence

The cone of influence which will result from pumping of the aquifer must be estimated for proper placement of monitoring wells. Analysis of the cone of influence is performed using: (1) analytical techniques described in Section 5.0; (2) known and/or estimated hydraulic characteristics of the aquifer system; and (3) the project-specific discharge rate.

4.1.2 Recovery Wells

Recovery well design is mainly dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the recovery well and well screen should be sufficient to allow for installation of the submersible pump.
- The well screen should be of sufficient slot-size opening to prevent entrainment of finer grained sediment while keeping the screen intake velocity and head loss at a minimum.
- The recovery well should be properly developed prior to the aquifer test.

The screened interval of the recovery well is dependent upon the heterogeneity of the aquifer system. Under fairly homogeneous, isotropic conditions the recovery well should be screened over 70 to 80 percent of the aquifer's entire thickness. More heterogeneous, anisotropic conditions may require a specific screened interval dependent upon the formational unit to be tested. Under complex heterogeneous anisotropic conditions the placement of the recovery well screen must be evaluated by a qualified hydrogeologist.

4.1.3 Monitoring Wells

Monitoring well design is largely dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the monitoring well should be sufficient to allow for installation of water-level monitoring equipment and ground-water sampling equipment.

- A minimum of five monitoring wells should be used for the collection of water level and drawdown data.

- Monitoring wells should be properly developed prior to the aquifer test to ensure proper hydraulic continuity with the aquifer system.

Under fairly homogeneous, isotropic conditions the following rules for proper monitoring well placement should be observed:

- Monitoring well screens should extend to at least a depth equal to the midpoint of the recovery well.

- The closest monitoring well should be located at a radial distance, from the recovery well, equal to the saturated thickness of the aquifer.

- At least one monitoring well should be located outside of the predetermined cone of influence.

- For a confined aquifer, shallow monitoring wells should be placed in the overlying source bed (if any).

Figure 1 shows a typical setup of monitoring wells and the recovery well along with major assumptions for homogeneous, isotropic conditions. More heterogeneous, anisotropic aquifer systems may require discreet screen placement within specific geologic units. This placement shall be determined by a qualified hydrogeologist.

4.2 Antecedent Water-Level Monitoring

Antecedent water-level trends must be established prior to startup of the recovery well pump. Antecedent water-level trends include:

- Diurnal fluctuations due to daily ground-water withdrawals in the area

- Seasonal water-level fluctuations

- Changes in water levels due to changes in the atmospheric barometric pressures
- Changes in water levels due to tidal cycles
- Changes in water levels due to daily traffic patterns

Dedicated, continuously recording, pressure transducers and data logging systems should be employed to establish antecedent water-level trends. Water levels should be monitored at no greater than hourly intervals in at least three monitoring wells to establish any spatial trends within the aquifer system. Data should be collected until a water level trend can be established but for no less than a 24-hour period. The observed antecedent trend also can be used to locate possible ground-water supply wells which may cause interference during the aquifer test. All efforts should be made to reduce the use of any well which may cause interference during the aquifer test.

During analyses of the aquifer-test data, antecedent water-level trends are extrapolated out through the pumping and recovery phases of the aquifer test. Water level and drawdown data are then corrected for any established antecedent trend.

4.3 Pumping Phase

During the pumping phase of the aquifer test the recovery well pump is switched on and run at the specified discharge rate. All technicians who will be collecting data shall synchronize their watches and begin collecting water level data when the recovery well pump is switched on. Water level data shall be collected at the time intervals shown in Table 1 or as specified by the project manager. All appropriate aquifer-test data shall be recorded on the aquifer-test data record sheet (Figure 2). Each person recording data shall sign and date, in ink, his or her record sheet.

The duration of the aquifer test shall be determined by the project manager. For a valid aquifer test the recovery well should be pumped until changes in drawdown become negligible, the hydraulic gradient becomes constant and/or changes in the discharge rate from aquifer to the recovery well approach zero. These criteria determine the type of solution, steady state or non-steady state, that will be used in analyzing the aquifer-test data. The forementioned conditions indicate steady-state conditions. Steady-state conditions will allow for the most accurate evaluation of the aquifer's hydraulic characteristics.

The duration of the aquifer test can be estimated during the design phase while judgments in the field as to the state of ground-water flow can be made once data has been collected for a sufficient period of time. Aquifer tests should however be run for no less than 12 hours. A practical maximum duration of 72 hours will provide sufficient data to characterize hydraulic properties of the aquifer. Large aquifer systems which may be used for major municipal supplies should be tested for 7 to 14 days to evaluate long-term pumping affects.

The discharge rate should be measured and adjusted (if necessary) at least hourly throughout the entire aquifer test. Ground water withdrawn from the recovery well must be discharged at a suitable distance outside of the radial cone of influence. This will prevent artificial recharge back into the aquifer system. If artificial recharge into the aquifer system being tested occurs, erroneous results will be calculated during analyses of the aquifer-test data.

4.4 Recovery Phase

During the recovery phase of the aquifer test the recovery well pump is switched off and water level rebounds are measured in all monitoring wells and the recovery well at the time intervals listed in Table 1. Monitoring of the water level rebound should continue until the aquifer has recovered to within 90 percent of its initial water level. It is usually sufficient to monitor for a 24-hour period. Long-term pumping, however, should be followed by long-term monitoring of water level recovery and post-aquifer-test water level trends.

5.0 AQUIFER-TEST ANALYSES

Once the aquifer test has been completed, field data must be reduced, assimilated and evaluated. Data analyses include three main procedures:

1) Water level data must be corrected for antecedent trends observed during phase two of the aquifer test.

2) Time-drawdown data collected during the pumping phase of the aquifer test must be plotted on log-log paper. These log-log plots are then matched to known aquifer type responses shown in Figure 3.

3) Aquifer-test data must be analyzed using appropriate type solutions as listed in Tables 2 and 3.

Aquifer-test data which has been corrected for any antecedent trends is plotted on log-log paper. These plots are then matched to typical responses of known aquifer types as shown in Figure 3. Once the type of aquifer response has been evaluated, the project manager must select the proper solutional technique to evaluate the aquifer-test data. Table 2 lists the various methods of data analyses and calculated hydraulic properties which can be used if the following assumptions are met:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping, the piezometric surface and the phreatic surface are nearly horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- Storage within the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

More detailed analyses may be necessary under complex hydrogeologic conditions. Table 3 lists techniques of aquifer-test analyses with replaced assumptions indicative of more complex hydrogeologic conditions. In any case, the assumptions on which analyses are based should be stated in the final report.

All aquifer-test analyses must be performed by a qualified hydrogeologist. The list of references at the end of this SOP provide detailed methods of analyses for all hydrogeologic conditions.

6.0 REVIEW

All data reduction, calculations and assumptions shall be verified, by a qualified person other than the originator, in accordance with SOP 2005 (Numerical Analysis and Peer Review). In addition to protocols listed in SOP 2005, the verification process shall include a review of:

- Assumptions made for antecedent water-level trends

- Major assumptions as listed in Section 5.0 for aquifer type and solutional technique
- Overall method of analyses and reporting of results

All reviews shall be signed by the reviewer prior to reporting of analyses to the client.

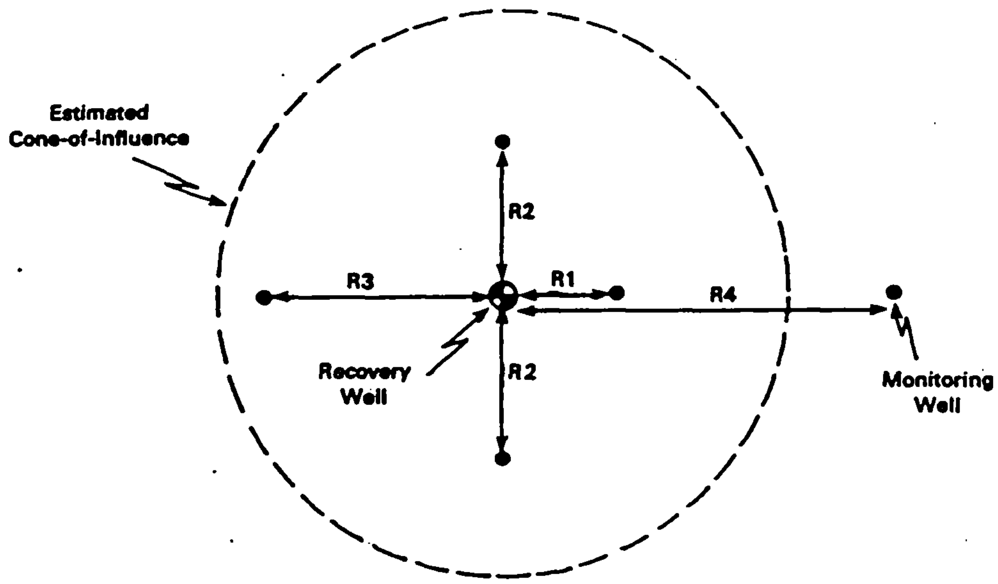
REFERENCES

Ground Water Manual, A Water Resources Technical Publication, U.S. Department of the Interior, 1977.

Ground Water; R. Allan Freeze and John A. Cherry, 1979.

Practical Aspects of Ground Water Modeling, Flow, Mass and Heat Transport, and Subsidence; Analytical and Computer Models. William C. Walton, 1984.

Analysis and Evaluation of Pumping Test Data; Bulletin 11. Kruseman G.P. and DeRidder N.A.



Where:

R = Radial Distance from the Recovery Well
and $R1 < R2 < R3 < R4$

Aquifer Assumptions:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping the piezometric surface and phreatic surface are nearly horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- The storage in the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

Figure 1 Generalized Aquifer Test Set Up

TABLE 1

PREDETERMINED MEASUREMENT INTERVALS

Time Since Test-Started	Measurement Interval
0 - 1 hr	1 - 5 mins
1 - 3 hrs	15 mins
3 - 5 hrs	30 mins
5 - 24 hrs	60 mins
24 - 48 hrs	2 - 4 hrs
48 - 72 hrs	4 - 8 hrs

Well #______
Pg 1 of____

AQUIFER TEST DATA RECORD SHEET

Date ____________ Technician ____________
Project ____________
Depth of Well ____________ Length of Screen____________
Time Test Started ________hrs. Length of Casing (AGS) ____________
Radial Distance from Pump Well ____________
Static Water Level (TOC) ____________

Watch Time	Time Since Test Started	Water Level from T.O.C.	Adjusted Water Level	Drawdown (ft)	Pump Rate

ENSR

Figure 2 Aquifer Test Data Record Sheet

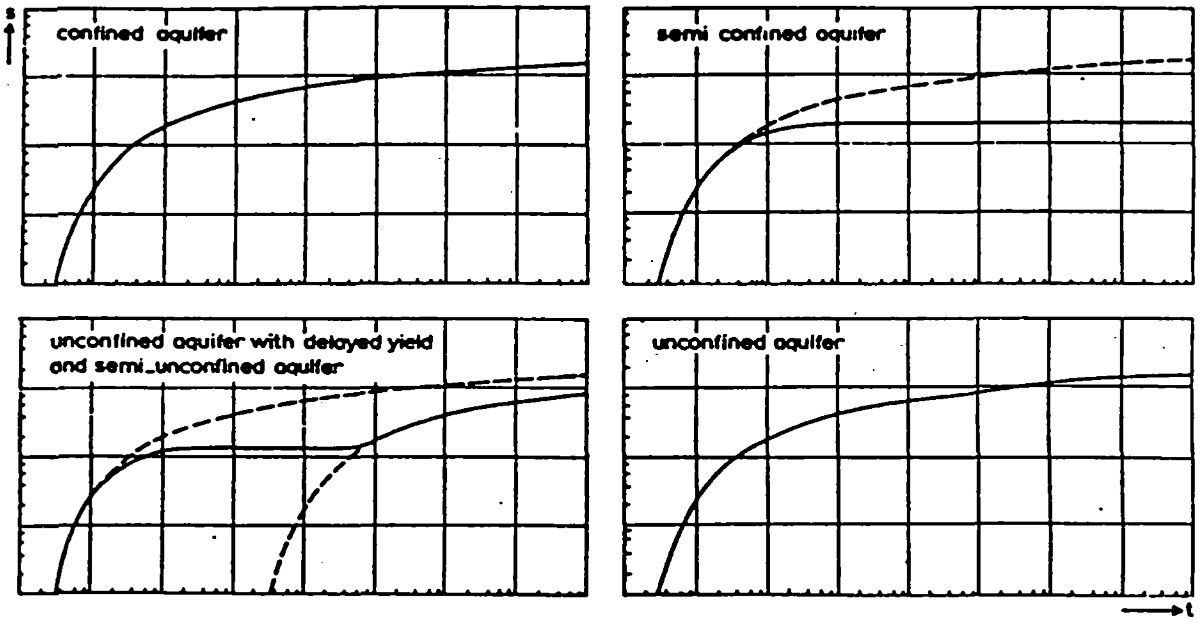


Figure 3 Typical Time-Drawdown Curves for Different Aquifer Types

TABLE 2

ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Aquifer Type	Type of Solution	Method of Analysis Name	Method of Analysis Type	Calculated Parameters*
confined	steady state	Thiem	calculation	T,K
	unsteady state	Theis	curve fitting	T,S,K
		Chow	nomogram	
		Jacob	straight line	T,S,K
		Theis recovery	straight line	T,K
semi confined	steady state	De Glee	curve fitting	T,C,K,L
		Hantush Jacob	straight line	T,C,K,L
		Ernst mod. Thiem meth.	calculation	T,K
	unsteady state	Walton	curve fitting	T,S,K,C,L
		Hantush I	inflection point	T,S,K,C,L
		Hantush II	inflection point	
		Hantush III	curve fitting	T,S,K,C,L
unconfined with delayed yield and semi-unconfined	unsteady state	Boulton	curve fitting	$T, S_A, S_Y, B, 1/\alpha, K$
unconfined	steady state	Thiem-Dupuit	calculation	T,K
unsteady state	as for confined aquifers			T,S,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; S_A = Storativity; S_Y = Specific Yield; $1/\alpha$ = Delay Index; B = Drainage Factor

TABLE 3

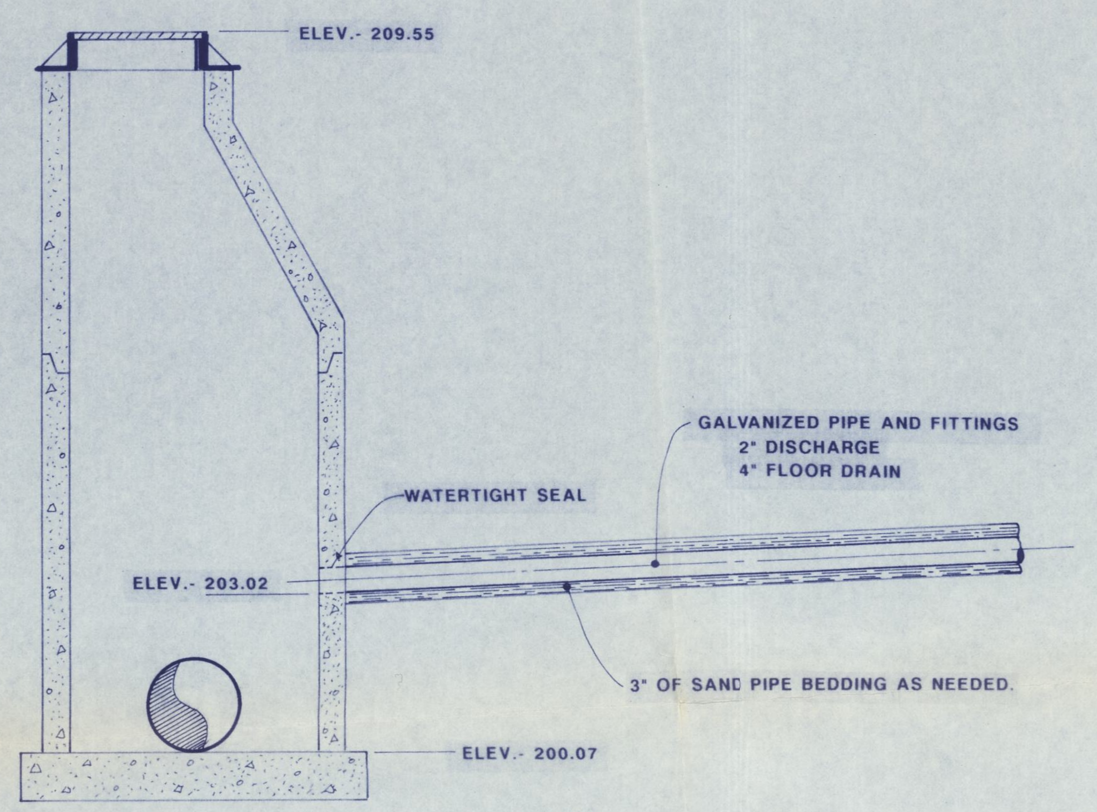
ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Replaced Assumption(s)	Aquifer Type	Type of Solution	Method of Analysis Name	Method of Analysis Type	Conditions	Calculated Parameters*
Aquifer crossed by one or more fully penetrating recharge or barrier boundaries	confined or unconfined	steady state	Dietz	calculation	recharge boundaries only	T,K
		unsteady state	Stallman	curve fitting	recharge and/or barrier boundaries	T,K,S
			Hantush image	straight-line	one recharge boundary	
Aquifer homogeneous, anisotropic and of uniform thickness	confined or unconfined	unsteady state	Hantush	calculation		T_X,T_Y,S,K
			Hantush-Thomas	calculation	for recovery data also	T_X,T_Y,S,K
	semi confined	unsteady state	Hantush	calculation		T_X,T_Y,S,C,L,K
Aquifer homogeneous and isotropic; but thickness varies exponentially	confined	unsteady state	Hantush	curve fitting	$dD/dx < 0.20$	T,S,K
Prior to pumping the phreatic surface slopes in the direction of flow	unconfined	steady state	Culmination point	calculation		T,K
		unsteady state	Hantush	curve fitting	$i < 0.20$	T,S,K
Discharge rate variable	confined or unconfined	unsteady state	Cooper-Jacob	straight line	step-type pumping	T,K,S
			Aron-Scott	straight line	continuously decreasing discharge	T,K,S
			Sternberg	straight line	continuously decreasing discharge	T,K,S
			Sternberg recovery	straight line	continuously decreasing discharge	T,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; T_X,T_Y = Transmissivity in the X and Y direction.

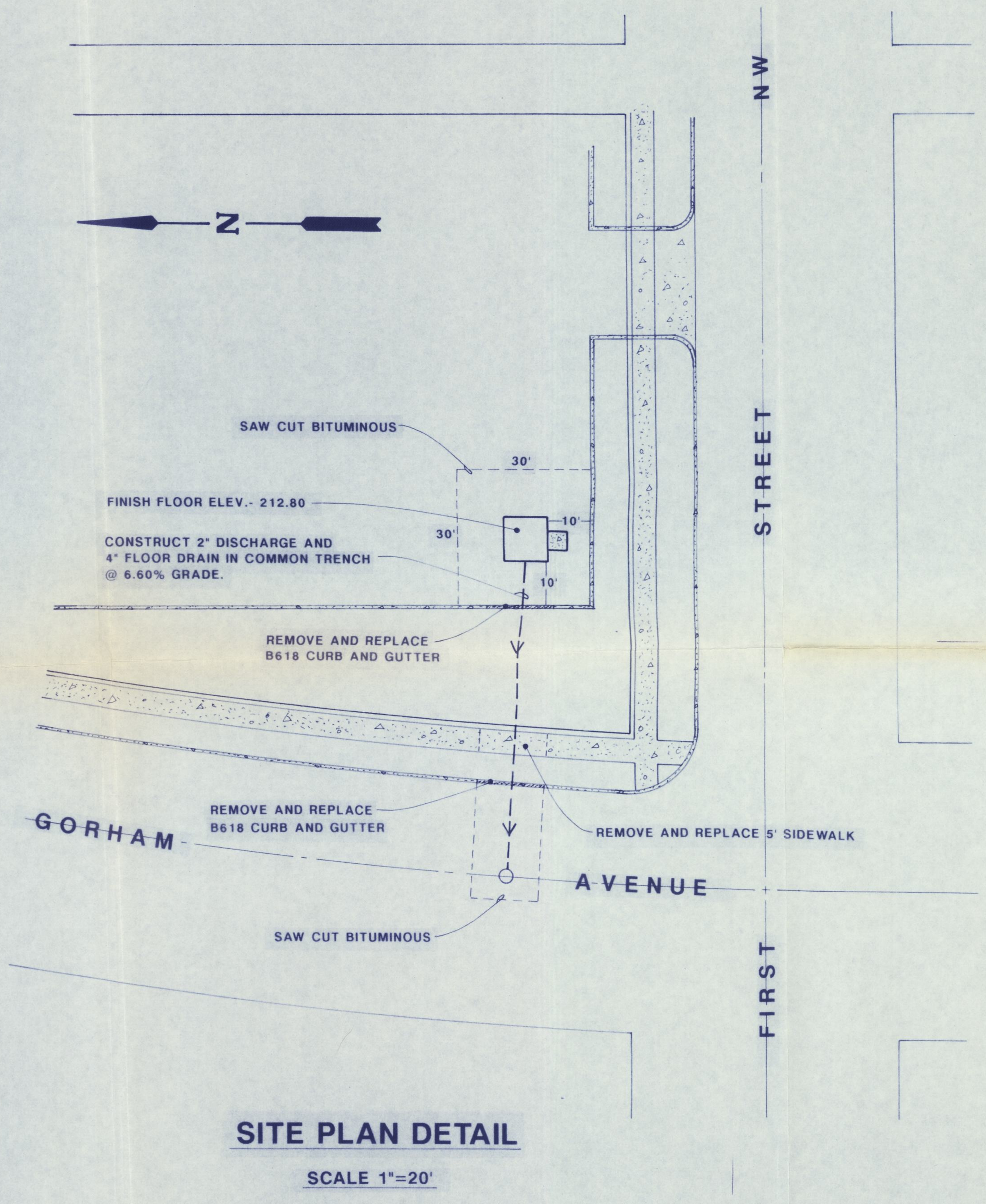
APPENDIX C

Blueprints



MANHOLE DETAIL

TYPICAL CONNECTION TO EXISTING MANHOLE FOR
DISCHARGE PIPES AND FLOOR DRAINS
NO SCALE



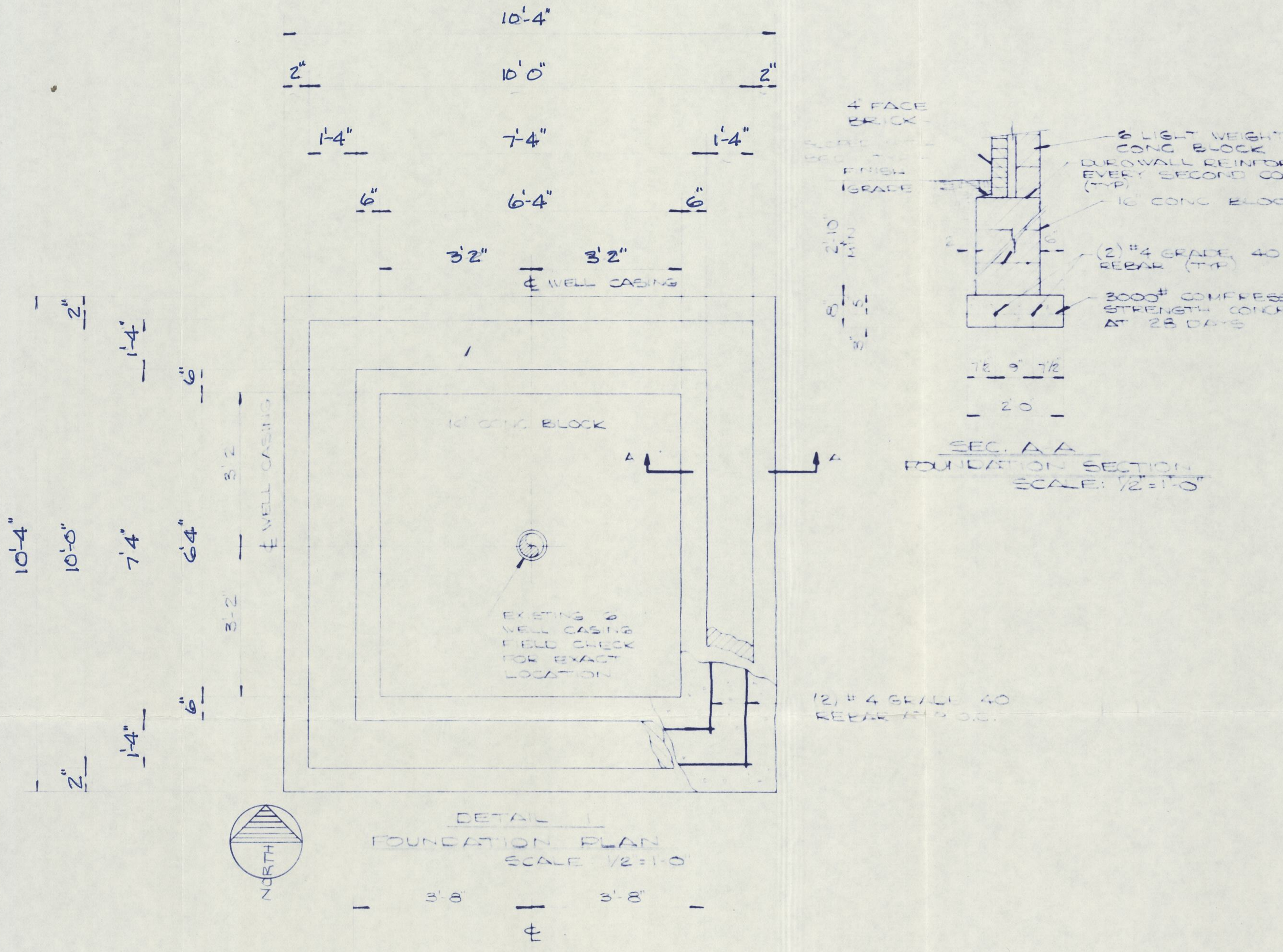
SITE PLAN DETAIL

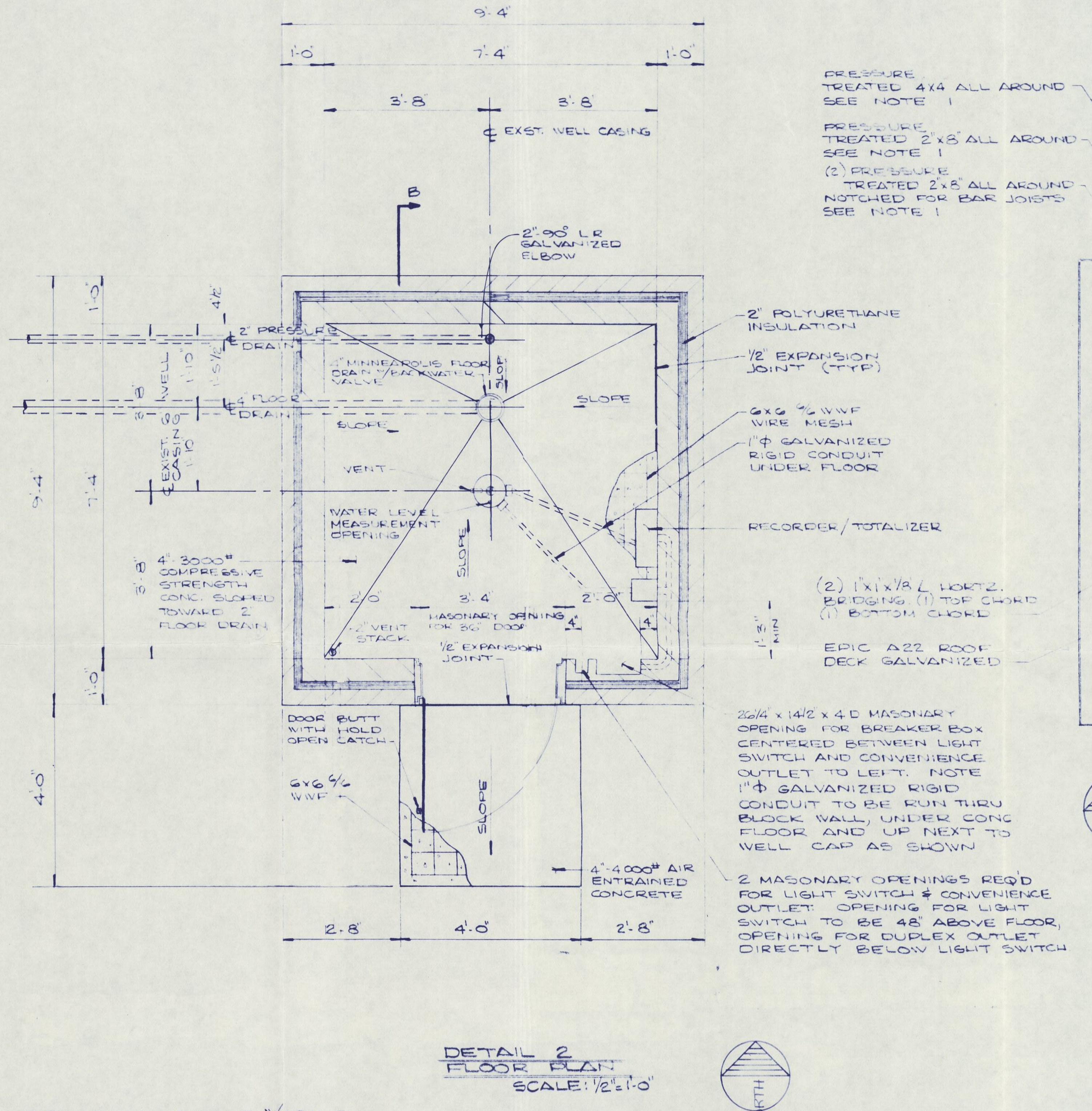
SCALE 1"=20'

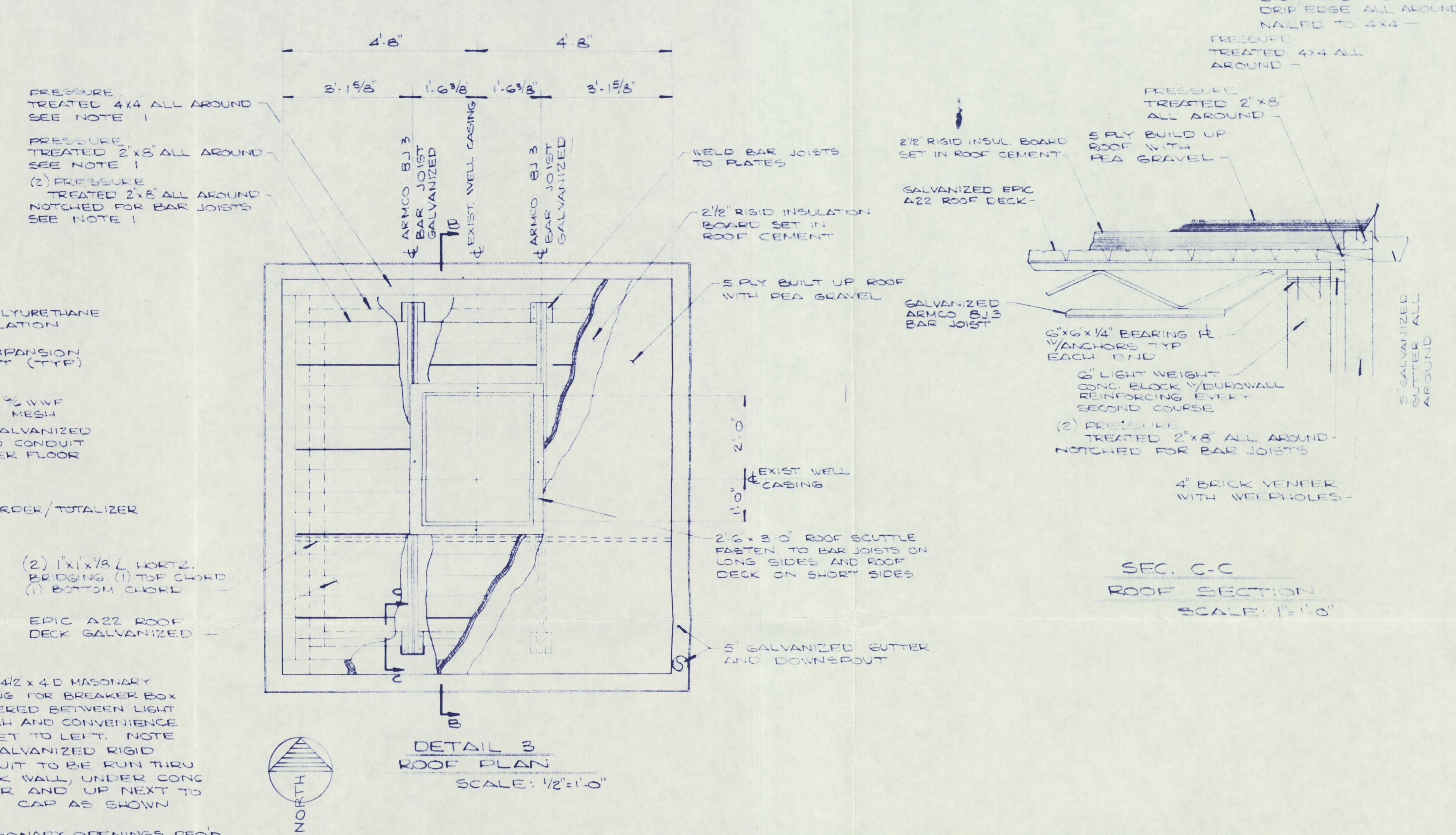
REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

W439 GRADIENT CONTROL WELL BUILDING

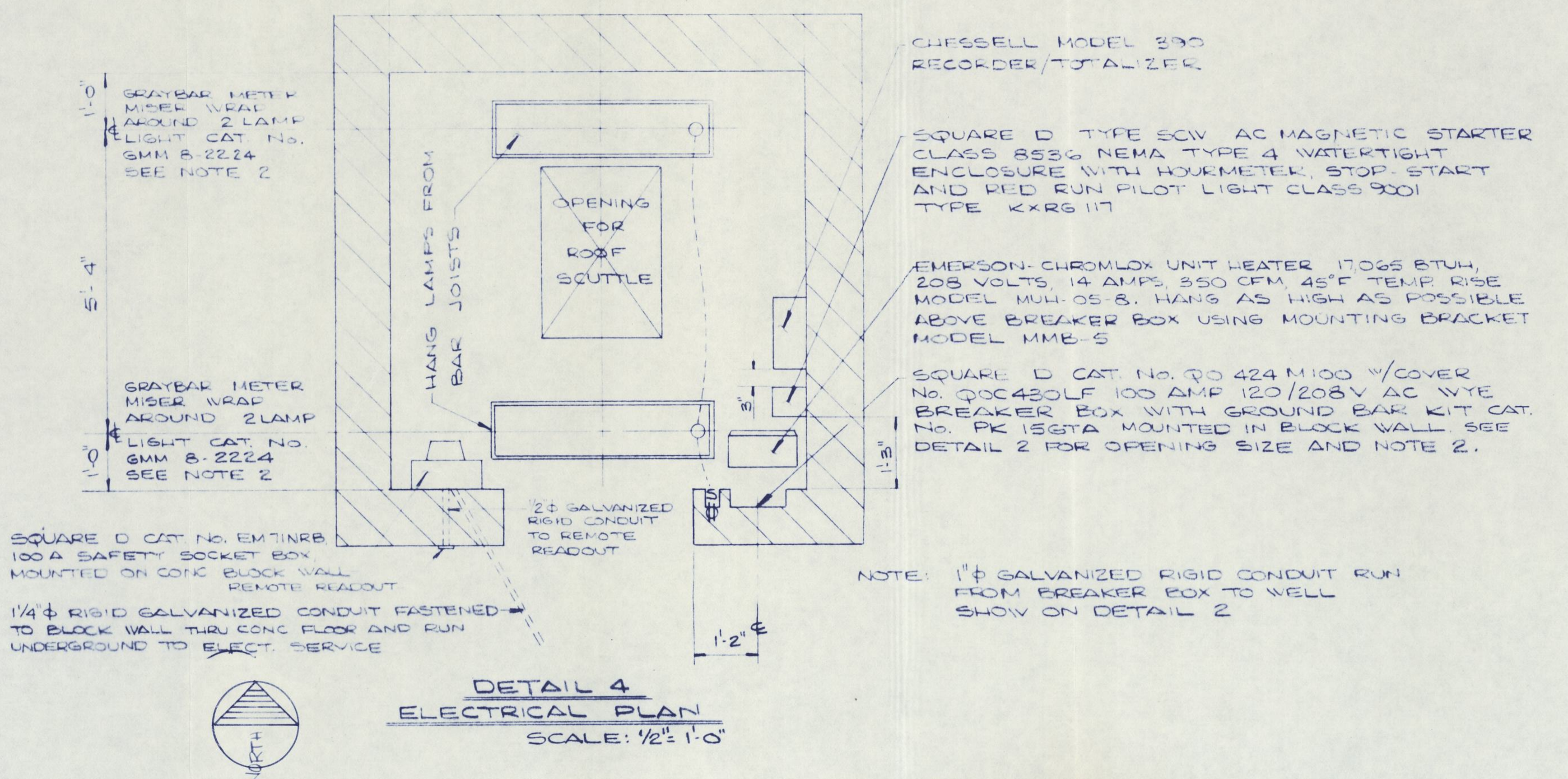
DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AWO	2/3/93	JG	2/10/93	ST. LOUIS PARK, MN.	
SCALE		APPROVED BY	DATE	DRAWING NO.	
AS SHOWN		JG	2/10/93		

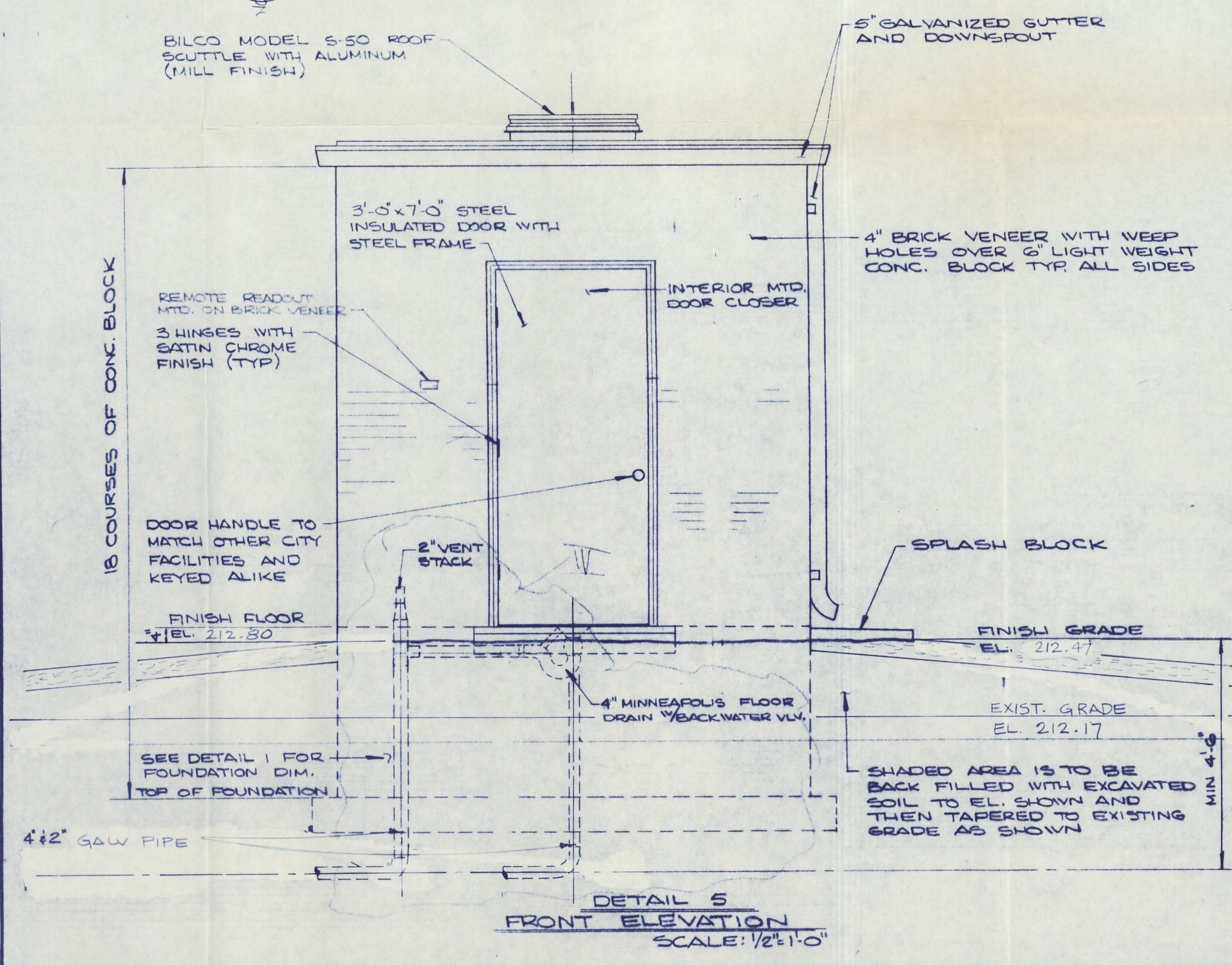


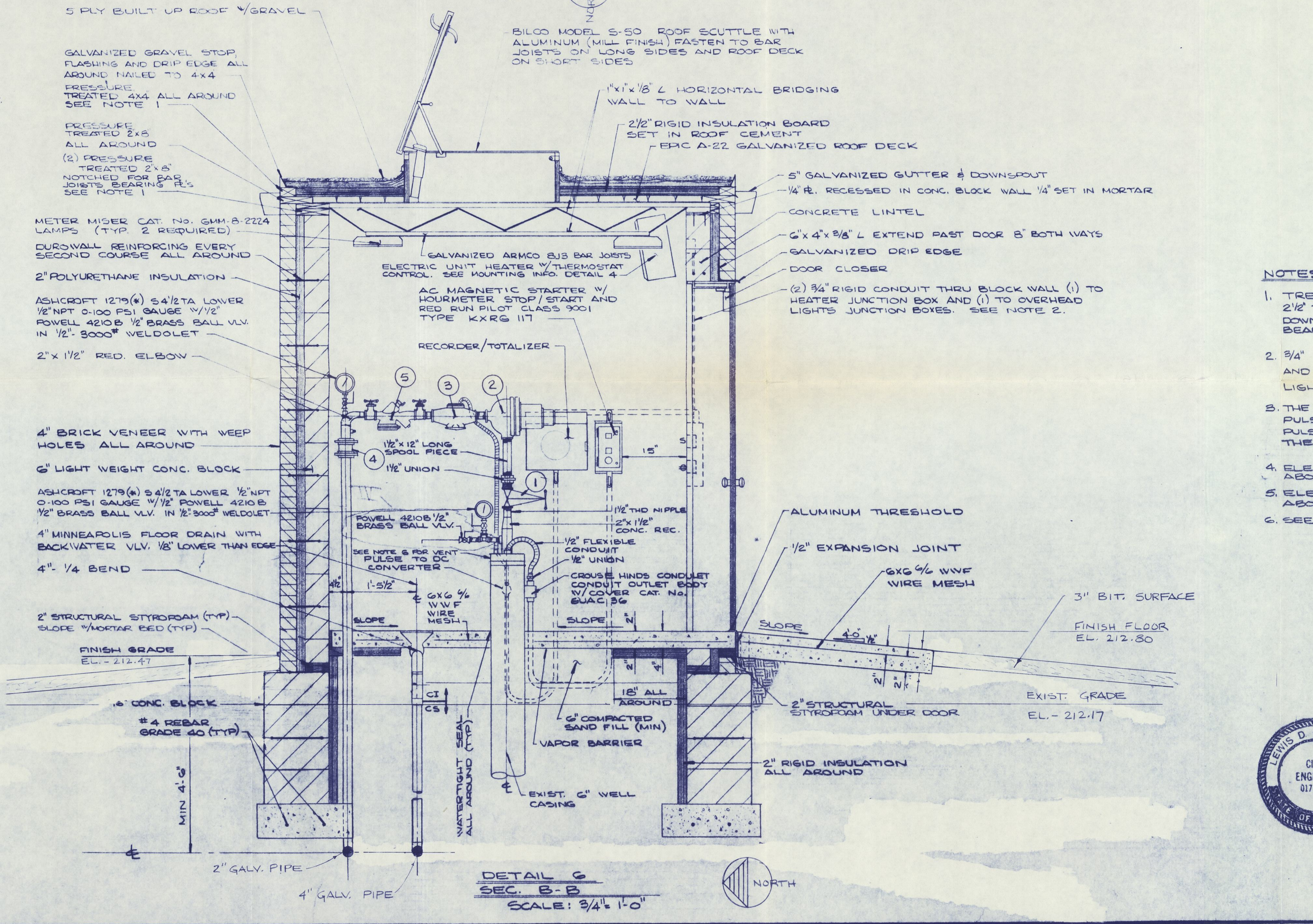




WELL COMPONENT SCHEDULE						
WELL	DISCHARGE SIZE	POWELL GATE VALVE FIG / SIZE	KATES FLOW CONTROL CONTROLLER/SIZE	HERSEY TURBINE METER WITH TOTALIZER / SIZE	TRW MISSION DUO CHECK II/ SIZE	FEBCO REDUCED PRESS. BACKFLOW PREVENTER
W 439	2" (REDUCE TO 1½")	500 / 1½" NPT	IB11T-CDG / 1½" NPT	MVR 100-C-1-150-P-G-C / 1½" NPT	K15 HMF / 2"	825Y/1½" NPT







NOTES:

1. TREATED 4X4 MUST BE CUT DOWN FOR A TOTAL THICKNESS OF 2½" TO MATCH INSULATION THICKNESS (2) TREATED 2X8 MUST BE CUT DOWN FOR A TOTAL THICKNESS OF 2½" TO MATCH BAR JOIST BEARING END THICKNESS.
2. 3/4" RIGID CONDUIT IN WALL TO BOXES ABOVE EACH LIGHT AND BOX BEHIND HEATER THEN FLEX CONDUIT TO LIGHTS AND HEATER.
3. THE HERSEY FLOW METER WILL HAVE AN R-38 ELECTRONIC PULSE OUTPUT DEVISE THAT WILL SIGNAL A MODEL 1005 PULSE TO DC CONVERTER WHICH WILL SEND OUTPUT TO THE CHESSEL 390 RECORDER / TOTALIZER.
4. ELEVATION TOP OF SAFETY SOCKET BOX IS TO BE 5'-0" ABOVE FINISH FLOOR
5. ELEVATION TOP OF REMOTE READOUT IS TO BE 4'-6" ABOVE CONC. STOOP.
6. SEE DWG 861737-302 FOR WELL CAP AND VENT INFO.

LEWIS D. LOCKE, JR. CIVIL ENGINEER 017565 0 STATE OF MINNESOTA

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Lewis D Locke Jr

Date 5/7/87 Reg. No. 0175650

PHOTOSTAT	DATE:
MICRO FILM	DATE:

REVISIONS

NO.	DATE	BY	DESCRIPTION	CHK'D	APP'D
IV	2/2/88	AK	AS BUILT REVISIONS		
III	7/2/87	AK	CHANGED CONC. BLOCK SIZE BELOW GRADE, MOVED METER SOCKET INSIDE BLDG CHANGED FLOOR DRAIN LINES TO 4" ADDED NOTES 4, 5 & 6 ALSO GEN. REV.		
II	5/7/87	AK	REDREW DRAWING AND CHANGED FLOW CONTROLER FROM 4FA1-1 TO IB11T-CDG		

REFERENCE DRAWINGS

DRAWING NUMBER	DESCRIPTION

REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS INDIANA

W439 GRADIENT CONTROL WELL BUILDING

DRAWN BY	DATE	CHECKED BY	DATE	PLANT	REVISION
AK	5/7/87	L D Locke	5/7/87	St. Louis Park, MINN.	IV
SCALE		APPROVED BY	DATE	DRAWING NUMBER	
INDICATED		John [illegible]	5/7/87	861737-603	

REVISED 2-3-93 AWO

2

QUALITY ASSURANCE PROJECT PLAN FOR THE DRIFT AQUIFER GRADIENT CONTROL WELL AT THE REILLY TAR & CHEMICAL CORPORATION - ST. LOUIS PARK SITE

Prepared by

The City of St. Louis Park
St. Louis Park, MN 55416

Approved by:______________________________ Date:______________________
James N. Grube, Project Manager
City of St. Louis Park, MN

Approved by:______________________________ Date:______________________
Quality Assurance Officer
U.S. EPA Region V

Approved by:______________________________ Date:______________________
Remedial Project Manager
U.S. EPA Region V

Approved by:______________________________ Date:______________________
Project Manager
Minnesota Pollution Control Agency

1.0 INTRODUCTION

1.1 Background

ENSR Consulting and Engineering (ENSR) and the City of St. Louis Park (City) will complete certain tasks in fulfillment of the Consent Decree (CD) and Remedial Action Plan (RAP) for the St. Louis Park site. This Quality Assurance Project Plan (QAPP) pertains to all work to be performed by ENSR, City and other contractors in constructing well W439. Further details on the work to be performed, its purpose and the methodology to be employed may be found in the project Site Management Plan.

1.2 Quality Objectives

The purpose of this QAPP is to define the quality assurance and quality control provisions to be implemented to ensure that:

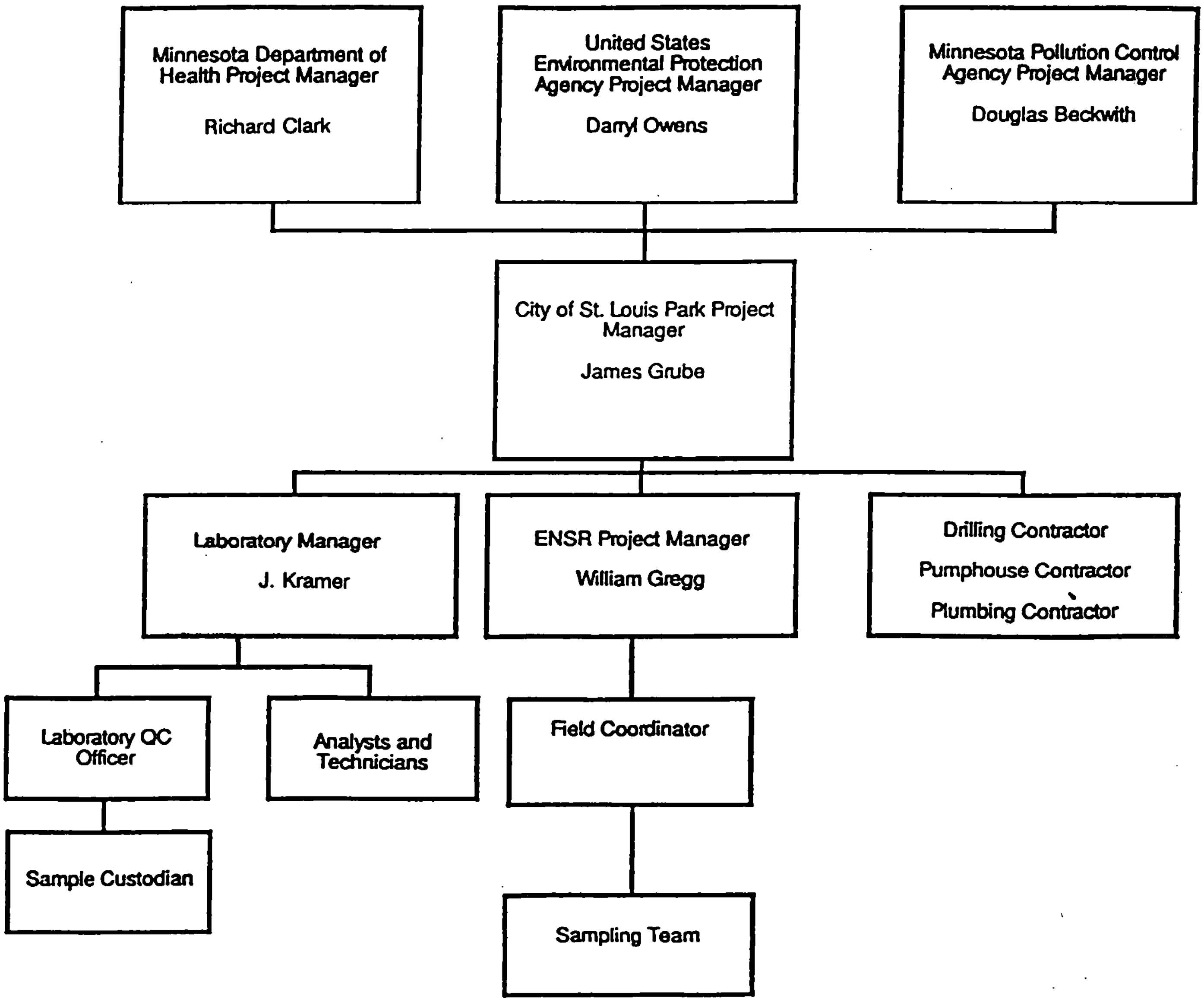
- The resulting gradient control well conforms to design specifications given in the project Site Management Plan
- The work is performed in an efficient manner
- Field records generated during the course of the field work are sufficiently complete and accurate to satisfy data analysis and report requirements
- All assumptions, formulas, interpretations and numerical analyses used in the process of deriving reported results and conclusions are documented in permanent records

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization is illustrated in Figure 2-1. The City Project Manager, Mr. James Grube, will oversee and coordinate all project activities. The ENSR Project Manager/Field Coordinator, Mr. William Gregg, will schedule and direct all field activities, including the design and implementation of the aquifer tests. The ENSR Project Manager/Field Coordinator is also responsible for maintaining records of the work performed on the project and for archiving those records in the Central File upon completion of the work. The City Project Manager will direct the engineering aspects of the work, including the installation of the sewer line connections and pumphouse. The Project Quality Assurance Officers are responsible for ensuring that this QAPP is implemented by their respective organizations, and that project data undergo technical and peer review, as necessary. The pump installation contractor will perform all work necessary to install the pump and make it operational. The plumbing contractor will install piping and connections to the sewer lines and the pumphouse contractor will install the well house to enclose the well and pump.

Figure 2-1

Project Quality Assurance Organization



3.0 QA/QC - FIELD ACTIVITIES

3.1 Training

In order to ensure that the contractors doing the field work can do so in a cooperative and efficient manner, instruction and guidance will be provided by the City Project Manager and the ENSR Project Manager/Field Coordinator to instill an understanding of the project objectives and plans and of the respective roles of the contractors.

3.2 Contractor Quality Control

Contractor quality control is that system of activities which ensure that products or services obtained from contractors fulfill the needs of the project. Contractor quality control begins with contractor procurement. The contractor procurement process considers:

- Bidder's qualifications in terms of personnel and physical resources, Quality Assurance program, and Health and Safety program
- Results of pre-qualification audits, if appropriate
- Price and technical qualifications

Periodic quality control inspections of each contractor will be performed by the City Project Manager and the ENSR Project Manager/Field Coordinator to evaluate adherence to the QAPP and the project Health and Safety Plan. Inspection will include (as appropriate):

- Type and condition of equipment
- Calibration procedures
- Personnel qualifications
- Decontamination procedures
- Documentation

Results of the inspections will be entered in the field notebook.

3.3 Document Control and Recordkeeping

Document control for the Drift Aquifer gradient control well work serves a two-fold purpose. It is a formal system of activities that ensures that:

1. All participants in the project are promptly informed of revisions of the QAPP

2. All critical documents generated during the course of the work are accounted for during, and at the end of the project

This QAPP and all Standard Operating Procedure (SOP) documents have the following information on each page:

- Document number
- Page number
- Total number of pages in document
- Revision number
- Revision date

When any of these documents are revised, the affected pages are reissued to all personnel listed as document holders with updated revision numbers and dates. Issuance of revisions is accompanied by explicit instructions as to which documents or portions of documents have become obsolete.

Control of, and accounting for documents generated during the course of the project is achieved by assigning the responsibility for document issuance and archiving. For the Drift Aquifer gradient control well work, the City Project Manager and the ENSR Project Manager/Field Coordinator have this responsibility.

Documentation for the project will either be recorded in non-erasable ink, or will be photocopied promptly upon completion, and the photocopies dated. All documents will be signed by the person completing them.

4.0 AQUIFER TEST

The aquifer tests will be performed in accordance with ENSR SOP No. 7730, Aquifer Test and Data Evaluation, and the project Site Management Plan (Appendix A).

5.0 NUMERICAL ANALYSIS AND PEER REVIEW

All numerical analyses, including manual calculations, mapping, and computer modeling will be documented and subjected to quality control review in accordance with ENSR SOP 1005, Numerical Analysis and Peer Review (Appendix B). All records of numerical analyses will be legible, reproduction-quality and complete enough to permit logical reconstruction by a qualified individual other than the originator.

6.0 AUDITS AND CORRECTIVE ACTION

ENSR conducts periodic audits to assess the level of adherence to QA policies, procedures and plans.

Whenever quality deficiencies are observed that warrant immediate attention, formal corrective action request forms are issued to the City Project Manager by the Quality Assurance Department. The QA Department retains one copy of the form when it is issued. The City Project Manager completes the form and signs it when corrective action has been implemented, and returns the original to the QA Officer to close the loop.

The QA Department maintains a record of all corrective action requests and reports their status to ENSR management in a quarterly report.

Should an audit be conducted on the Drift Aquifer gradient control well work activities, the City will be apprised of the audit findings and of any corrective action that is requested and performed.

7.0 CONSTRUCTION APPROVAL

The City Project Leader will provide written notification to the United States Environmental Protection Agency (U.S. EPA) and Minnesota Pollution Control Agency (MPCA) Project Leaders within three days of completing construction of the well W439 well house and pumping system. Following receipt of such notification, the EPA and MPCA Project Leaders (or their designees) will inspect the system and the City will demonstrate that the system has been constructed and operates in accordance with the approved plan. Following their inspection of the system, the EPA and MPCA Project Leaders (or Alternates) will notify the City Project Leader in writing as to whether the Drift Aquifer gradient control well system is approved or disapproved. In the event that the system is approved, the City will commence operation of the system within ten days of receipt of the approval letter. In the event that the system is disapproved, the U.S. EPA and MPCA Project Leaders will explain in writing the basis for the disapproval and the items that needs to be corrected, and the City will either correct the items or explain in writing why the system should be approved as constructed. If corrections are made, the notification, inspection, and approval/disapproval sequence described above will be repeated.

Notwithstanding the procedures described above, the City, EPA, MPCA and Reilly reserve all of their rights under the Consent Decree for dispute resolution, extension requests and related actions with respect to the construction, inspection, approval and operation of well W439.

APPENDIX A

ENSR SOP 7730 - Aquifer Test and Data Evaluation

1.0 PURPOSE/APPLICABILITY

This SOP is concerned with the procedures necessary for aquifer-test design, aquifer-test performance and general techniques of data evaluation. The scope of this SOP is limited to general procedures necessary to properly understand and organize an aquifer test. A detailed test plan should be prepared before beginning an aquifer test, following the general guidelines given in this SOP. More detailed studies concerning aquifer tests and analyses can be found in any of the various references listed at the end of this SOP.

Aquifer tests are generally conducted to evaluate the hydraulic properties of an aquifer system as they relate to remedial action design criteria and/or water supply studies.

2.0 RESPONSIBILITIES

The project manager or his delegate (a qualified hydrologist, hydrogeologist, geologist, etc.) will have the responsibility of designing an appropriate aquifer-test program specific to the project needs. Additionally, he or she will be responsible for coordinating any second or third parties and ensuring that all procedures are performed in accordance with SOP and the aquifer-test plan. Any deviation from the SOPs or the aquifer-test plan will be fully documented in a daily log book.

2.1 ERT Personnel

The ERT project manager or his delegate will be responsible for:

- Aquifer-test design - This will include review of pertinent hydrogeologic literature (reports, boring and well logs, etc.) and, based on that information, the preparation of a site-specific aquifer-test plan that specifies: (1) the placement of monitoring and recovery wells; (2) site-specific discharge rates and point of discharge; and (3) time intervals at which water level data will be collected.
- Aquifer-test performance - This includes: (1) implementation of the aquifer test in accordance with job-specific protocols given in the aquifer-test plan; and (2) recording aquifer-test data.
- Reduction and evaluation of aquifer-test data - This will include: (1) evaluation of antecedent water-level trends; (2) evaluation of the pumping phase water-level data; and (3) evaluation of the recovery phase water-level data.

2.2 Drillers

It is the responsibility of the driller to provide the necessary equipment for monitoring and recovery well installation as specified in SOP 7220 and as modified by the project manager or his delegate. If the driller is to supply submersible pumps, generators, flow meters, discharge lines or any other equipment necessary to the job the project manager shall explain in detail to the subcontracted driller the job-specific equipment needs. During setup and/or installation of the equipment the project manager shall oversee the performance and adherence to the test plan. Additionally, during the entire aquifer test, if the driller is involved in activities such as monitoring the performance of the pumps, fuel supplies, etc., the project coordinator shall ensure that the driller adheres to the test plan.

2.3 Second or Third Parties

During the aquifer test other involved parties shall be monitored for performance and adherence to the test plan. Any deviation shall be corrected and fully recorded by the project coordinator in a daily log book.

3.0. SUPPORTING MATERIALS

The following list identifies the types of equipment which may be used during an aquifer-test program. Exact equipment needs will be project-specific and will be detailed in the aquifer-test plan.

3.1 ERT

- Electric water-level indicator
- Steel surveyors tape and plopper
- Pressure transducer and data logging system
- 100-foot surveyors tape
- Field portable printer or computer (compatible with data logging system)
- Aquifer-test record sheets/clip board
- Daily log book

- Log-log and semi-log graph paper
- Watch
- Calculator
- Decontamination equipment (required for personal protection during aquifer tests in potentially contaminated environments or if sampling for chemical analysis will be included):

  Alconox detergent
  Chemical-free paper towels
  Deionized water w/squeeze bottle
  Methanol w/squeeze bottle
  Trash bags
  Tap water (5 gallons)
  Buckets

- Ground-water sampling kit from lab (if applicable)
- Personnel health and safety equipment (as specified by the HSO)
- Submersible pump
- Aeration column (for stripping volatiles out of discharged ground water)

3.2 Driller

- Tankers for collecting discharged ground water
- Submersible pump
- Generator and fuel
- Flow meters and control valves
- Discharge line

3.3 Supporting SOPs

- 2005 – Numerical Analysis and Peer Review
- 7220 – Monitoring Well Construction and Installation

4.0 GENERAL AQUIFER TEST DESIGN AND OPERATIONAL PROTOCOLS

Aquifer tests are broken down into four separate phases, all of which must be performed for proper evaluation of the hydraulic properties of the aquifer. Any deviation from these four phases must be fully documented and justified. These four phases are:

- Aquifer-test design
- Antecedent water-level monitoring
- Pumping
- Recovery
- Aquifer-Test Design

Prior to an aquifer test an initial review of site hydrological and geological conditions must be performed and a detailed aquifer-test plan must be prepared. Information concerning aquifer thickness, aquifer type, transmissivity, hydraulic conductivity, storativity, etc., can be obtained or estimated from the following types of sources:

- Boring logs
- Well records
- USGS water resource reports
- State water resource reports
- Textbook tables and charts

The hydrogeologic information gathered from these sources is necessary to:

- estimate the cone of influence at a specific discharge rate;
- properly and strategically locate monitoring wells and the recovery well; and
- determine the proper time intervals at which time-drawdown data should be collected.

The following subsections provide guidelines for preparation of aquifer-test plans.

4.1.1 Cone of Influence

The cone of influence which will result from pumping of the aquifer must be estimated for proper placement of monitoring wells. Analysis of the cone of influence is performed using: (1) analytical techniques described in Section 5.0; (2) known and/or estimated hydraulic characteristics of the aquifer system; and (3) the project-specific discharge rate.

4.1.2 Recovery Wells

Recovery well design is mainly dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the recovery well and well screen should be sufficient to allow for installation of the submersible pump.
- The well screen should be of sufficient slot-size opening to prevent entrainment of finer grained sediment while keeping the screen intake velocity and head loss at a minimum.
- The recovery well should be properly developed prior to the aquifer test.

The screened interval of the recovery well is dependent upon the heterogeneity of the aquifer system. Under fairly homogeneous, isotropic conditions the recovery well should be screened over 70 to 80 percent of the aquifer's entire thickness. More heterogeneous, anisotropic conditions may require a specific screened interval dependent upon the formational unit to be tested. Under complex heterogeneous anisotropic conditions the placement of the recovery well screen must be evaluated by a qualified hydrogeologist.

4.1.3 Monitoring Wells

Monitoring well design is largely dependent upon the heterogeneity of the aquifer system to be tested. Standard design considerations which should be evaluated under all situations are as follows:

- The inside diameter of the monitoring well should be sufficient to allow for installation of water-level monitoring equipment and ground-water sampling equipment.

- A minimum of five monitoring wells should be used for the collection of water level and drawdown data.

- Monitoring wells should be properly developed prior to the aquifer test to ensure proper hydraulic continuity with the aquifer system.

Under fairly homogeneous, isotropic conditions the following rules for proper monitoring well placement should be observed:

- Monitoring well screens should extend to at least a depth equal to the midpoint of the recovery well.

- The closest monitoring well should be located at a radial distance, from the recovery well, equal to the saturated thickness of the aquifer.

- At least one monitoring well should be located outside of the predetermined cone of influence.

- For a confined aquifer, shallow monitoring wells should be placed in the overlying source bed (if any).

Figure 1 shows a typical setup of monitoring wells and the recovery well along with major assumptions for homogeneous, isotropic conditions. More heterogeneous, anisotropic aquifer systems may require discreet screen placement within specific geologic units. This placement shall be determined by a qualified hydrogeologist.

4.2 Antecedent Water-Level Monitoring

Antecedent water-level trends must be established prior to startup of the recovery well pump. Antecedent water-level trends include:

- Diurnal fluctuations due to daily ground-water withdrawals in the area

- Seasonal water-level fluctuations

- Changes in water levels due to changes in the atmospheric barometric pressures
- Changes in water levels due to tidal cycles
- Changes in water levels due to daily traffic patterns

Dedicated, continuously recording, pressure transducers and data logging systems should be employed to establish antecedent water-level trends. Water levels should be monitored at no greater than hourly intervals in at least three monitoring wells to establish any spatial trends within the aquifer system. Data should be collected until a water level trend can be established but for no less than a 24-hour period. The observed antecedent trend also can be used to locate possible ground-water supply wells which may cause interference during the aquifer test. All efforts should be made to reduce the use of any well which may cause interference during the aquifer test.

During analyses of the aquifer-test data, antecedent water-level trends are extrapolated out through the pumping and recovery phases of the aquifer test. Water level and drawdown data are then corrected for any established antecedent trend.

4.3 Pumping Phase

During the pumping phase of the aquifer test the recovery well pump is switched on and run at the specified discharge rate. All technicians who will be collecting data shall synchronize their watches and begin collecting water level data when the recovery well pump is switched on. Water level data shall be collected at the time intervals shown in Table 1 or as specified by the project manager. All appropriate aquifer-test data shall be recorded on the aquifer-test data record sheet (Figure 2). Each person recording data shall sign and date, in ink, his or her record sheet.

The duration of the aquifer test shall be determined by the project manager. For a valid aquifer test the recovery well should be pumped until changes in drawdown become negligible, the hydraulic gradient becomes constant and/or changes in the discharge rate from aquifer to the recovery well approach zero. These criteria determine the type of solution, steady state or non-steady state, that will be used in analyzing the aquifer-test data. The forementioned conditions indicate steady-state conditions. Steady-state conditions will allow for the most accurate evaluation of the aquifer's hydraulic characteristics.

The duration of the aquifer test can be estimated during the design phase while judgments in the field as to the state of ground-water flow can be made once data has been collected for a sufficient period of time. Aquifer tests should however be run for no less than 12 hours. A practical maximum duration of 72 hours will provide sufficient data to characterize hydraulic properties of the aquifer. Large aquifer systems which may be used for major municipal supplies should be tested for 7 to 14 days to evaluate long-term pumping affects.

The discharge rate should be measured and adjusted (if necessary) at least hourly throughout the entire aquifer test. Ground water withdrawn from the recovery well must be discharged at a suitable distance outside of the radial cone of influence. This will prevent artificial recharge back into the aquifer system. If artificial recharge into the aquifer system being tested occurs, erroneous results will be calculated during analyses of the aquifer-test data.

4.4 Recovery Phase

During the recovery phase of the aquifer test the recovery well pump is switched off and water level rebounds are measured in all monitoring wells and the recovery well at the time intervals listed in Table 1. Monitoring of the water level rebound should continue until the aquifer has recovered to within 90 percent of its initial water level. It is usually sufficient to monitor for a 24-hour period. Long-term pumping, however, should be followed by long-term monitoring of water level recovery and post-aquifer-test water level trends.

5.0 AQUIFER-TEST ANALYSES

Once the aquifer test has been completed, field data must be reduced, assimilated and evaluated. Data analyses include three main procedures:

1) Water level data must be corrected for antecedent trends observed during phase two of the aquifer test.

2) Time-drawdown data collected during the pumping phase of the aquifer test must be plotted on log-log paper. These log-log plots are then matched to known aquifer type responses shown in Figure 3.

3) Aquifer-test data must be analyzed using appropriate type solutions as listed in Tables 2 and 3.

Aquifer-test data which has been corrected for any antecedent trends is plotted on log-log paper. These plots are then matched to typical responses of known aquifer types as shown in Figure 3. Once the type of aquifer response has been evaluated, the project manager must select the proper solutional technique to evaluate the aquifer-test data. Table 2 lists the various methods of data analyses and calculated hydraulic properties which can be used if the following assumptions are met:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping, the piezometric surface and the phreatic surface are nearly horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- Storage within the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

More detailed analyses may be necessary under complex hydrogeologic conditions. Table 3 lists techniques of aquifer-test analyses with replaced assumptions indicative of more complex hydrogeologic conditions. In any case, the assumptions on which analyses are based should be stated in the final report.

All aquifer-test analyses must be performed by a qualified hydrogeologist. The list of references at the end of this SOP provide detailed methods of analyses for all hydrogeologic conditions.

6.0 REVIEW

All data reduction, calculations and assumptions shall be verified, by a qualified person other than the originator, in accordance with SOP 2005 (Numerical Analysis and Peer Review). In addition to protocols listed in SOP 2005, the verification process shall include a review of:

- Assumptions made for antecedent water-level trends

- Major assumptions as listed in Section 5.0 for aquifer type and solutional technique

- Overall method of analyses and reporting of results

All reviews shall be signed by the reviewer prior to reporting of analyses to the client.

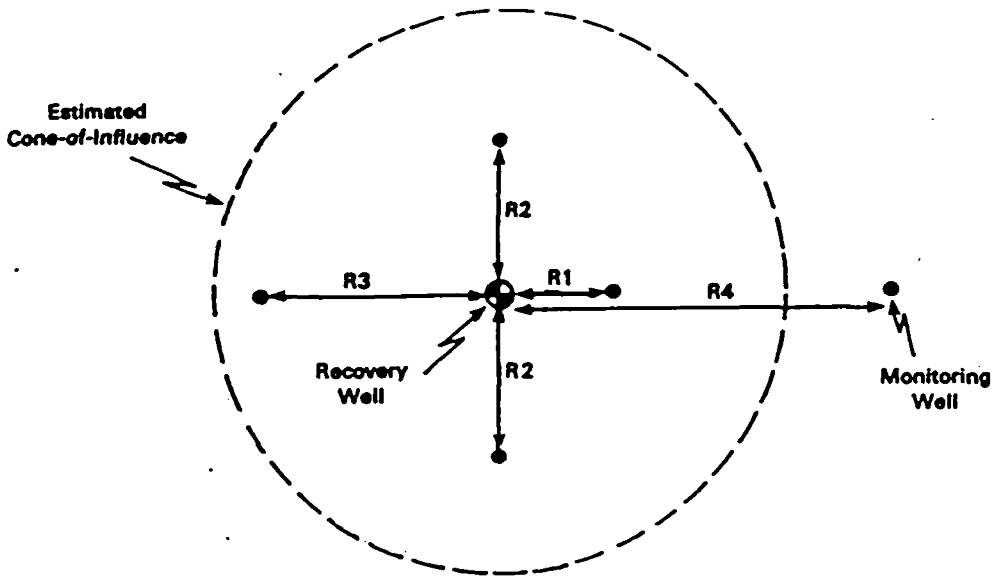
REFERENCES

Ground Water Manual, A Water Resources Technical Publication, U.S. Department of the Interior, 1977.

Ground Water; R. Allan Freeze and John A. Cherry, 1979.

Practical Aspects of Ground Water Modeling, Flow, Mass and Heat Transport, and Subsidence; Analytical and Computer Models. William C. Walton, 1984.

Analysis and Evaluation of Pumping Test Data; Bulletin 11. Kruseman G.P. and DeRidder N.A.



Where:

R = Radial Distance from the Recovery Well
and R1 < R2 < R3 < R4

Aquifer Assumptions:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- Prior to pumping the piezometric surface and phreatic surface are nearly-horizontal.
- The discharge rate is constant.
- The aquifer is fully penetrated by the recovery well.
- The storage in the recovery well can be neglected.
- Water removed from the aquifer is discharged instantaneously with a decline in hydraulic head.

Figure 1 Generalized Aquifer Test Set Up

TABLE 1

PREDETERMINED MEASUREMENT INTERVALS

Time Since Test-Started	Measurement Interval
0 - 1 hr	1 - 5 mins
1 - 3 hrs	15 mins
3 - 5 hrs	30 mins
5 - 24 hrs	60 mins
24 - 48 hrs	2 - 4 hrs
48 - 72 hrs	4 - 8 hrs

Well # ______
Pg 1 of ______

AQUIFER TEST DATA RECORD SHEET

Date ______________________ Technician ______________________

Project ____

Depth of Well __________________ Length of Screen __________________

Time Test Started ____________ hrs. Length of Casing (AGS) ____________

Radial Distance from Pump Well ______________________________

Static Water Level (TOC) ______________________________

Watch Time	Time Since Test Started	Water Level from T.O.C.	Adjusted Water Level	Drawdown (ft)	Pump Rate

ENSR

Figure 2 Aquifer Test Data Record Sheet

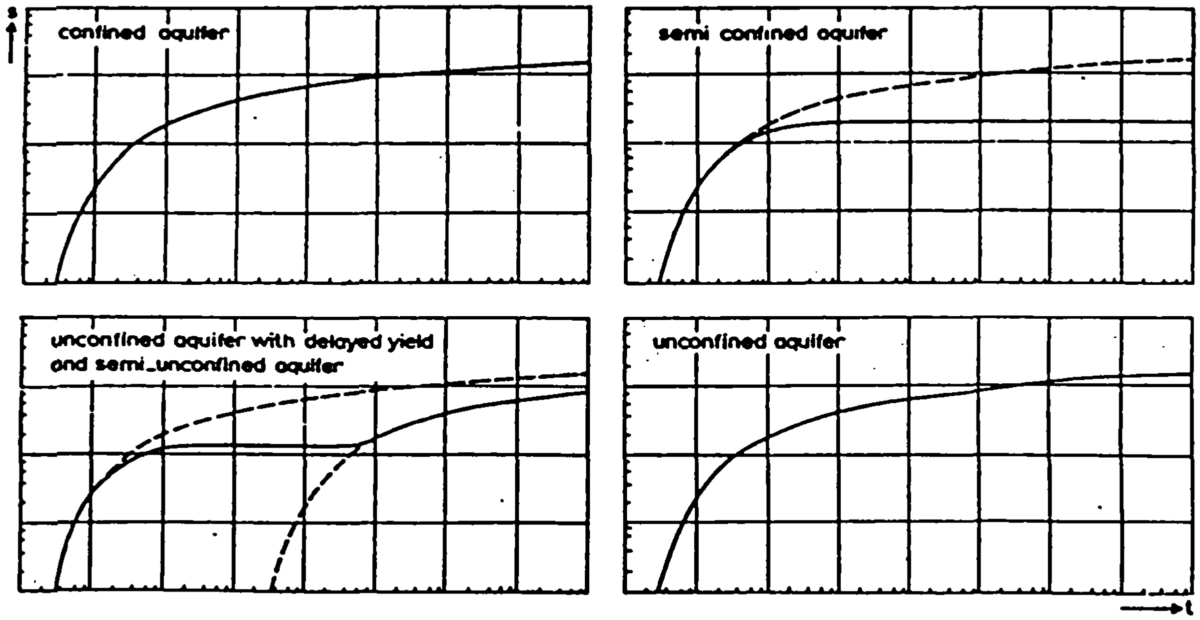


Figure 3 Typical Time-Drawdown Curves for Different Aquifer Types

TABLE 2

ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Aquifer Type	Type of Solution	Method of Analysis Name	Method of Analysis Type	Calculated Parameters*
confined	steady state	Thiem	calculation	T,K
	unsteady state	Theis	curve fitting	T,S,K
		Chow	nomogram	
		Jacob	straight line	T,S,K
		Theis recovery	straight line	T,K
semi confined	steady state	De Glee	curve fitting	T,C,K,L
		Hantush Jacob	straight line	T,C,K,L
		Ernst mod. Thiem meth.	calculation	T,K
	unsteady state	Walton	curve fitting	T,S,K,C,L
		Hantush I	inflection point	T,S,K,C,L
		Hantush II	inflection point	
		Hantush III	curve fitting	T,S,K,C,L
unconfined with delayed yield and semi-unconfined	unsteady state	Boulton	curve fitting	T,S_A,S_Y,B,1/α,K
unconfined	steady state	Thiem-Dupuit	calculation	T,K
unsteady state	as for confined aquifers			T,S,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; S_A = Storativity; S_Y = Specific Yield; 1/α = Delay Index; B = Drainage Factor

TABLE 3

ANALYTICAL PROCEDURES FOR EVALUATING AQUIFER-TEST DATA

Replaced Assumption(s)	Aquifer Type	Type of Solution	Method of Analysis: Name	Method of Analysis: Type	Conditions	Calculated Parameters[a]
Aquifer crossed by one or more fully penetrating recharge or barrier boundaries	confined or unconfined	steady state	Dietz	calculation	recharge boundaries only	T,K
		unsteady state	Stallman	curve fittng	recharge and/or barrier boundaries	T,K,S
			Hantush image	straight-line	one recharge boundary	
Aquifer homogeneous, anisotropic and of uniform thickness	confined or unconfined	unsteady state	Hantush	calculation		T_X,T_Y,S,K
			Hantush-Thomas	calculation	for recovery data also	T_X,T_Y,S,K
	semi confined	unsteady state	Hantush	calculation		T_X,T_Y,S,C,L,K
Aquifer homogeneous and isotropic; but thickness varies exponentially	confined	unsteady state	Hantush	curve fitting	dD/dx < 0.20	T,S,K
Prior to pumping the phreatic surface slopes in the direction of flow	unconfined	steady state	Culmination point	calculation		T,K
		unsteady state	Hantush	curve fitting	i < 0.20	T,S,K
Discharge rate variable	confined or unconfined	unsteady state	Cooper-Jacob	straight line	step-type pumping	T,K,S
			Aron-Scott	straight line	continuously decreasing discharge	T,K,S
			Sternberg	straight line	continuously decreasing discharge	T,K,S
			Sternberg recovery	straight line	continuously decreasing discharge	T,K

Note: T = Transmissivity; K = Horizontal Hydraulic Conductivity; S = Storativity; C = Hydraulic Resistance; L = Leakage Factor; T_X,T_Y = Transmissivity in the X and Y direction.

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APPENDIX B

ENSR SOP 1005 - Numerical Analysis and Peer Review

1. Purpose and Applicability

This document describes ENSR's procedure for ensuring that all data analyses for site investigations and other studies are correct and consistent with project objectives and are legibly and retrievably documented. The purpose of the documentation is to permit peer review and reconstruction of the logic by which any conclusions were deduced.

2. Responsibilities

The responsibility for implementation of this procedure on each project rests with the person performing the calculations.

The project manager is responsible for ensuring the completeness of project files.

3. Method of Documentation

3.1 Manual Calculations

3.1.1 All calculations shall be documented in legible, reproduction-quality records. The records shall be complete enough to permit logical reconstruction by a qualified person other than the originator.

3.1.2 Calculations should be maintained in division files during the project, and shall be placed into the central project file at the end of the project.

3.1.3 Each calculation should be assigned a unique identification number by an appropriate person. The calculations may be consecutively numbered within a given project. (e.g., D010-1, D010-2,...).

3.1.4 Calculations for each project should be kept in a binder with an index sheet.

3.1.5 Records of calculations shall contain, on each page, the initials of the originator and reviewer, the date, the project number, calculation number and page number.

3.1.6 Each calculation shall have a cover page which should contain:

- o client name,
- o project name and number,
- o calculation name and number,
- o total number of pages in the calculation,
- o date,
- o originator's signature.

3.1.7 The complete record of any series of calculations for a project shall have a cover page containing at least the following:

- o Statement of purpose
- o Brief description of method
- o Assumptions and justifications
- o Reference to input data sources
- o All numerical calculations, showing all units
- o Results
- o Reference to associated computer output
- o Signature of originator and date

3.2 Computer Programs

Documentation and qualification procedures for ENSR-written computer programs are detailed in ENSR SOP 1006. Each revision of each program is documented in an annotated hard copy of the software. Annotations should be sufficient to permit a qualified individual other than the originator to understand how the program works. Minimum contents of such a record are:

- o Program name
- o Originator's name
- o Input parameters
- o Date of printout
- o Revision number
- o Each page should be numbered, and should indicate the total number of pages in the record

These records are archived along with the qualification records in a central file.

3.3 Computer Program Output

3.3.1 All final computer program output used in a given project will be retained in hard copy in the project files. The output should be bound and assigned a unique reference number.

3.3.2 Each program output record shall contain at least the following:

- Name and revision date of program or model used
- Input parameters
- Name of user
- Date of run

3.4 Drawings

3.4.1 All drawings shall be labeled with a unique identification number, which might consist of the project number and a sequential drawing number (e.g. D010-1, D010-2,...).

3.4.2 All drawings shall be constructed using standardized symbols and nationally-recognized drafting standards

3.4.3 All drawings shall be signed and dated by the originator and checked, signed and dated by a reviewer.

3.4.4 All drawings to be published must be approved for issue by the project manager or his designee.

4. Method for Review and Revision

4.1 All calculations and drawings for each project shall be verified by a qualified person other than the originator.

4.2 Verification shall consist of a thorough check of the calculations for the following elements:

- Appropriateness of method,
- Appropriateness of assumptions,
- Correctness of calculations,
- Completeness of references,
- Completeness of record.
- Correctness of input parameters for calculations using computer programs.

4.3 Method of Review - It is the responsibility of the reviewer to assure that the methodology used and results obtained are correct. This may require verification of each number in the calculation, but this is usually not necessary. Typically, spot checks of the computations and visual inspection for the reasonableness constitute a sufficiently thorough check.

In some cases, it may be appropriate and economically feasible for the reviewer to perform a complete, independent calculation using a different, but appropriate method.

It is up to the reviewer to determine the appropriate method of review.

4.4 If the reviewer recommends revisions, the reviewer and originator will confer until any disagreements are resolved.

4.5 After determining that the calculation is acceptable, the reviewer will sign and date the cover page and initial and date the remaining pages.

4.6 A photocopy of the approved calculation record is made and filed in the central project file.

3

HEALTH AND SAFETY PLAN
FOR THE DRIFT AQUIFER GRADIENT CONTROL WELL
AT THE REILLY TAR & CHEMICAL CORPORATION - ST. LOUIS PARK SITE

February 22, 1994

1.0 INTRODUCTION

This Health and Safety Plan (Plan) applies to on-site personnel who will potentially be exposed to soil and/or ground water contamination during the construction of the Drift Aquifer gradient control well near the Reilly Tar & Chemical Corporation, St. Louis Park, site. This Plan has been designed to comply with, as a minimum, the requirements set forth in 29 CFR 1910.120, the OSHA standards governing hazardous waste operations. The ENSR Consulting and Engineering (ENSR) Project Manager and project staff will be responsible for continuous adherence to the safety procedures during site work at St. Louis Park. In no case may work be performed in a manner that conflicts with the intent of or the safety concerns expressed in this Plan. Other contractors involved in this project will be required to adhere to this Plan, as a minimum, and to conduct all work in accordance with applicable health and safety regulations, including 29 CFR 1910.120.

2.0 SCOPE OF WORK

Specific work activities at the site will include the installation of a new pumping well, connection of the well discharges to the sanitary sewer system, and erection of brick-and-block well house. A trench will be dug from the well houses to the sanitary sewer in order to make the discharge connections.

Exposure to the contaminants described below may occur during the performance of these activities.

3.0 CONTAMINANTS OF CONCERN AND EFFECTS OF OVEREXPOSURE

The contaminants of concern which have been identified at this site are coal tar and creosote related materials including naphthalene, other polynuclear aromatic hydrocarbons (PAH) and phenolic compounds.

Coal tar and creosote are typically irritating to the eyes, skin and respiratory tract. Acute skin contact may cause burning and itching while prolonged contact and poor hygiene practices may produce dermatitis. Prolonged skin contact with creosote must be avoided to prevent the possibility of skin absorption.

Naphthalene is a hemolytic agent which, upon overexposure to the vapor or ingestion of the solid, may produce a variety of symptoms associated with the breakdown of red blood cells. Naphthalene is also irritating to the eyes and repeated or prolonged contact has been associated with the production of cataracts.

Repeated exposure to certain PAH compounds has been associated with the production of cancer. Contact of PAH compounds with the skin may cause photosensitization of the skin producing skin burns after subsequent exposure to ultraviolet radiation.

Phenolics are generally strong irritants which can have a corrosive effect on the skin and can also rapidly penetrate the skin. Overexposure to phenols and phenolic compounds may cause convulsions as well as liver and kidney damage.

4.0 HAZARD ASSESSMENT

4.1 Initial

Because of the relatively low vapor pressures associated with PAH compounds (generally less than 10^{-4} mm/Hg at 20°C), they are not expected to present a vapor hazard at this site. The most likely threat of exposure to these compounds will be via skin contact.

Although naphthalene and phenol also have relatively low vapor pressures (0.05 and 0.36 mm/Hg at 20°C, respectively), there is a possibility that these substances may produce vapor hazards at this site under adverse conditions.

4.2 Continuing Hazard Assessment On-Site

4.2.1 Air Monitoring

An HNu photoionization detector (PID) equipped with a 10.2 eV lamp will be used to provide semiquantitative data on VOC concentrations in and around the breathing zone of workers. Air sampling will be conducted by taking and recording periodic readings in the breathing zone at each of the following locations:

- In the breathing zone near the opening of the well being drilled
- In the breathing zone over freshly-exposed soil being excavated

4.2.2 Action Limits

The American Conference of Governmental Industrial Hygienists (ACGIH) has established threshold limit values (TLV) for phenol and naphthalene at 5 and 10 ppm, respectively, as 8-hour time weighted averages (TWA). Based on these values, the action limits in Table 4-1 have been set. The lower limit of 5 ppm is based on the TLV for phenol while the upper limit of 50 ppm is based on a minimum protection factor of 10 for a half mask, air purifying respirator.

TABLE 4-1

Action Limits for Air Contaminants

Limit	Persistent Concentrations in Breathing Zone	Procedure
Lower	5 ppm	Don respirators, step up monitoring
Upper	50 ppm	Stop work and back off from immediate work area until levels subside in the breathing zone

4.2.3 Response

When the PID yields persistent breathing-zone readings at or above the lower action limit, workers in the affected area will don respirators. Air sampling will continue on a more frequent basis. If readings are persistent at or above the upper limit, workers shall back off from the immediate work area until measured breathing-zone concentrations fall below the lower limit, at which time operations will resume and normal air monitoring will continue. If breathing zone levels do not fall below the upper limit, workers are to leave the work area and report the condition immediately to the Health and Safety Manager. If necessary, engineering controls will be instituted to maintain vapor concentrations below the upper limit or arrangements will be made to upgrade to Level B protection.

5.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) will be donned, as necessary, based on the hazards encountered. Listed below is the PPE to be utilized during this project and the conditions requiring its use.

5.1 Personal Protective Equipment

- Coveralls Polyethylene coated Tyvek if work involves contact with contaminated soil or ground water
- Boots Chemical resistant type if work involves contact with contaminated soil or ground water
- Hard Hat When working in the vicinity of operating heavy machinery (i.e., drill rig, backhoe, etc.)
- Face Shield If splash hazard exists
- Gloves Nitrile for potential contact with contaminated soil or ground water
- Respirator MSA Comfo II with GMC-H Cartridges if PID readings exceeds 5 ppm or if dust or odors become objectionable
- Chemical Safety Goggles If eye irritation occurs

Because of the carcinogenicity of certain PAH compounds, and because of the skin hazards associated with PAH and phenolic compounds, it is important that appropriate protective clothing be worn during work activities, such as drilling and excavation, which may involve the possibility of skin contact with contaminated soil or ground water. As a minimum, the presence of visible creosote or coal tar-related material shall constitute evidence of contaminated soil or ground water.

6.0 HEALTH AND SAFETY TRAINING

Site personnel covered by this Plan must have received appropriate health and safety training prior to their working on the site. Training will include:

- Requirements for and use of respirators and PPE
- Cautions regarding the potential for trench collapse
- Required personal hygiene practices
- Requirements for employees to work in pairs
- Proper material handling
- Proper sampling procedures
- Maintenance of safety equipment
- Effective response to any emergency
- Responses to fires and explosions
- Emergency procedures (e.g., in the event of a trench collapse)
- Hazard zones
- Decontamination methods
- General safety precautions

A copy of the Standard Safety Procedures (Table 6-1) will be given to each worker covered by this Plan.

TABLE 6-1

Standard Safety Procedures
RTCC St. Louis Park Site

- Employees are required to work in pairs.

- Wash face and hands prior to eating, smoking, or leaving the site.

- No smoking or eating is allowed in the work area during active drilling, excavation or sampling activities.

- Wearing of contact lenses is not permitted in the work area.

- Contaminated material (e.g., Tyvek coveralls) must be properly disposed of before leaving the site.

- All work must be conducted in accordance with local, state and federal EPA and OSHA regulations, particularly 29 CFR 1910.120.

- The walls of trenches greater than 4 feet in depth must be sloped back to the angle of repose prior to entering. For average soil, an angle of 45° is recommended.

7.0 DECONTAMINATION

Administrative procedures require hygienic practices consistent with work hazards. Employees will be instructed in the training program on proper personal hygiene procedures.

Contaminated, reusable PPE, such as boots, hard hats, face shields and goggles will be decontaminated prior to leaving the site. The decontamination procedure is as follows:

- Rinse with water to remove gross contamination
- Wash in Alconox or equivalent detergent solution
- Rinse with clean water

Contaminated, disposable PPE, such as Tyvek coveralls and gloves, will be placed in 55-gallon drums and stored on-site while arrangements are made for disposal.

Respirators, if used, will be cleaned and disinfected after each day of use. The facepiece (with cartridge removed) will be washed in a hypochlorite (or equivalent) disinfecting solution, rinsed in warm water and air dried in a clean place.

8.0 EMERGENCY PROCEDURES

This Plan has been established to allow site operations to be conducted without adverse impacts on worker health and safety as well as public health and safety. In addition, supplementary emergency response procedures have been developed to cover extraordinary conditions at the site.

8.1 General

All accidents and unusual events will be dealt with in a manner to minimize a continued health risk to site workers. In the event that an accident or other unusual event occurs, the following procedure will be followed:

- First aid or other appropriate initial action will be administered by those closest to the accident/event. This assistance will be conducted so that those rendering assistance are not placed in a situation of unacceptable risk. In the event that a worker is caught in a trench collapse, call for emergency assistance immediately.

- All accidents/unusual events must be immediately reported to the ENSR Health and Safety Manager, the ENSR Project Manager, and the other contacts listed in Table 8-1.

- All workers on-site should conduct themselves in a mature, calm manner in the event of an accident/unusual event, to avoid spreading the danger to themselves, surrounding workers and the community.

8.2 Responses to Specific Situations

Emergency procedures for specific situations are given in the following paragraphs.

8.2.1 Worker Injury

If an employee in a contaminated area is physically injured, Red Cross first-aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If an excavation collapses and a worker is caught, call for emergency assistance immediately. If the person is in no immediate danger, do not attempt to move him. Internal injuries could be worsened. If the employee can be moved, he will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing (if any) will be removed,

TABLE 8-1

Notification Checklist
RTCC St. Louis Park Site

In the event of an extraordinary event that might be damaging to personnel or adjacent property, immediate notification of the proper emergency service will be required. The proper emergency service is determined by the nature of the emergency.

Emergency Notification

Fire Department	911
Ambulance	911
Police Department	911
Methodist Hospital	932-5000
Poison Control Center	800-332-3073

Directions to Methodist Hospital: From the site on Gorham Avenue, go southeast (one block) to Walker Street. Go west on Walker Street (approximately 0.2 mile) to Louisiana Avenue. Go south on Louisiana Avenue (approximately 0.7 mile). Methodist Hospital is on left (east) side of Louisiana (see attached map).

ENSR Contacts

Health and Safety Manager - Kevin Powers	617-369-8910
Project Manager - William Gregg	612-924-0117

Other Contacts

MPCA - Douglas Beckwith	612-296-7288
EPA - Darryl Owens	312-886-7341
City of St. Louis Park - James Grube	612-924-2551

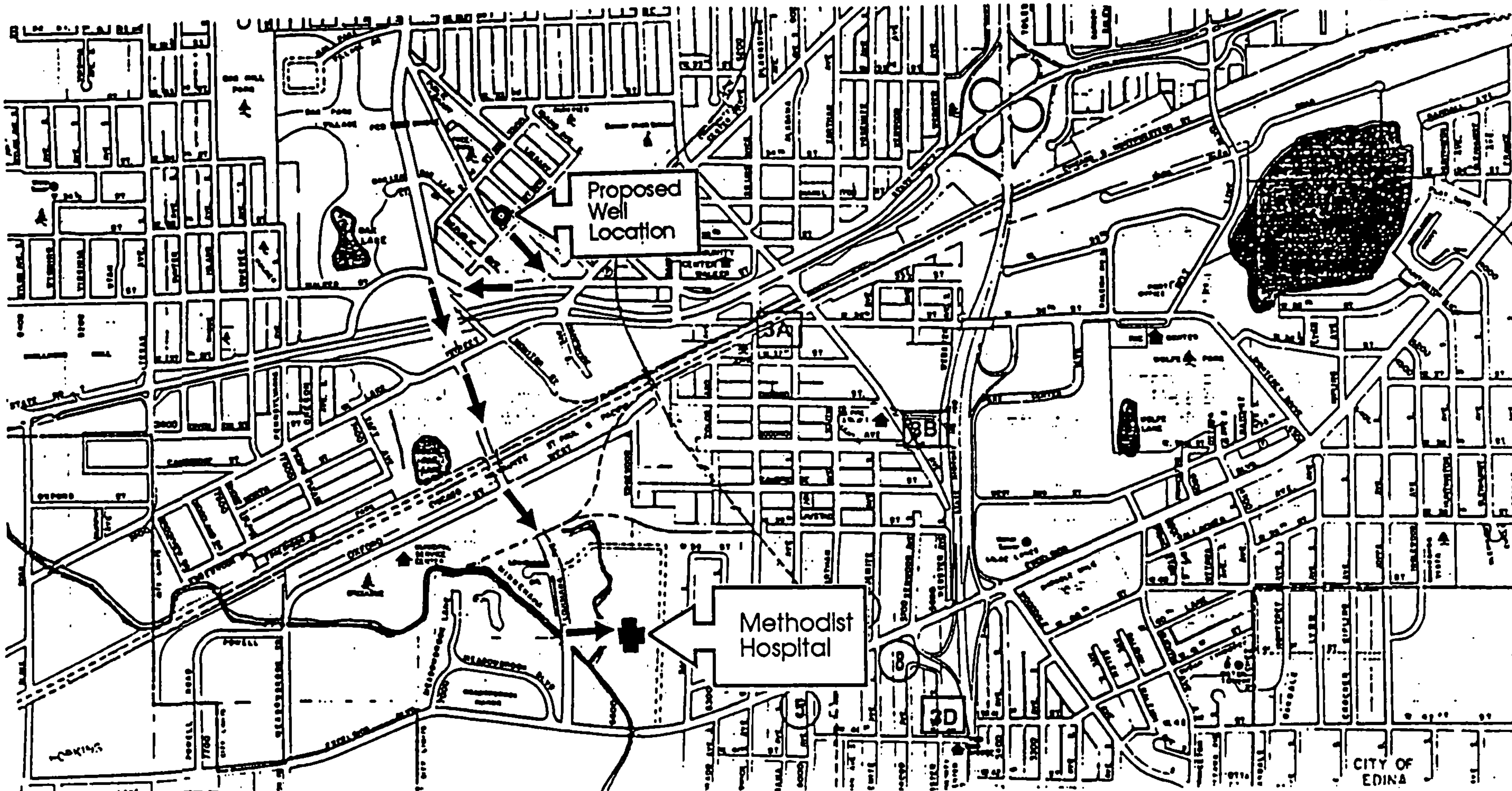

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Figure 8-1
Hospital Location Map
St. Louis Park, Minnesota

FILE: 1620013	DATE: 1/29/93	PRJ. NO.: 1620-013-200

emergency first-aid administered, and transportation to a local emergency medical facility awaited.

If the injury to the worker is chemical in nature (e.g., overexposure), the following first-aid procedures are to be instituted:

- Eye Exposure If contaminated solids or liquids get into the eyes, wash eyes immediately using large amounts of water and lifting the lower and upper lid occasionally. Obtain medial attention immediately.

- Skin Exposure If contaminated solids or liquids get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. Obtain medical attention immediately when exposed to concentrated solids or liquids.

- Inhalation If a person inhales large amounts of a toxic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

- Swallowing When contaminated solids or liquids have been swallowed, the Poison Control Center will be contacted and their recommended procedures followed.

8.3 Notification

8.3.1 Checklist

The names and phone numbers of all personnel and agencies that could be involved in emergency responses have been determined. Table 8-1 provides the notification checklist for use at the St. Louis Park site.

8.3.2 Documentation

The ENSR Project Manager will provide a report to the Health and Safety Manager containing the following information regarding any incidents implicating health and safety concerns:

- The event (including date and time) that necessitated the notification and the basis for that decision

- Date, time, and names of all persons/agencies notified and their response

- Resolution of the incident (including duration) and the method/corrective action involved

This report will be submitted within five working days of the resolution of the event.

4

COMMUNITY RELATIONS PLAN
FOR THE DRIFT AQUIFER GRADIENT CONTROL WELL
AT THE REILLY TAR & CHEMICAL CORPORATION - ST. LOUIS PARK SITE

February 22, 1994

COMMUNITY RELATIONS PLAN

Construction of the well W439 will be undertaken pursuant to the provisions of the Consent Decree and Remedial Action Plan for the Reilly Tar & Chemical Corporation, St. Louis Park, Minnesota, NPL site. All community relations programs related to this work will be coordinated through the following agencies:

United States	Ms. Judy Beck U.S. Environmental Protection Agency Region V (312) 353-1325
State of Minnesota	Ms. Susan Brustman Minnesota Pollution Control Agency (612) 296-7769
City of St. Louis Park	Mr. James Grube City of St. Louis Park (612) 924-2551